ROYAL BOTANIC GARDENS, KEW.

BULLETIN
OF
MISCELLANEOUS INFORMATION.

Nos. 9 & 10] [1917

XXIX.—THE FLORA OF THE SOMME BATTLEFIELD.

The ground over which the Battle of the Somme was fought in the late summer and autumn of 1916 rises gradually towards Bapaume, and at the same time is gently undulating with some well-marked branching valleys initiating the drainage system of the area. Before the war the land was for the most part under cultivation, but on the highest levels there were large areas of woodland such as High Wood and Delville Wood, now shattered and destroyed, which will live as famous names in history.

The Butte of Warlencourt, reduced by bombardment to a bare mound of chalk, is seen by the remnants of stumps to have been covered with trees, and was no doubt just such a feature in the landscape as Barbury Camp or other clumps of trees on our English downs. Many an obscure village—and they were fairly numerous—has become immortal, but there is scarcely anything left to mark their site.

Villages, roads, open country, and woodland have been destroyed and ploughed up again and again by shells, with the result that hardly a level spot can be found. The surface of the ground is everywhere more or less deeply pitted by shell-holes of varying size and depth, and can best be imitated by arranging innumerable cups and basins as closely together as possible so that their rims shall reach a general level. It is only on the rims of the shell-holes that walking is possible.

During last winter and spring all this country was a dreary waste of mud and water, the shell-holes being so well puddled that the water has remained in them, and even in the height of the summer there were innumerable ponds, more or less permanent, in every direction.

The underlying rock is everywhere chalk with a covering of loam of varying thickness. As a result of the bombardment the old surface soil has been scattered and the chalk partially exposed. One effect of the shelling, however, has been to disintegrate the underlying chalk and produce a weathering effect which has been accentuated by the winter rains, snow and frost. A general mixing of chalk, subsoil, and scattered top soil and also a rounding of the sharp edges has taken place, so that

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instead of the new surface soil being sterile, the shelling and weathering have "cultivated" the land. That this is so is proved by the appearance of the Somme battlefield during the past summer.

Looking over the devastated country from the Bapaume Road one saw only a vast expanse of weeds of cultivation which so completely covered the ground and dominated the landscape that all appeared to be a level surface. In July poppies predominated, and the sheet of colour as far as the eye could see was superb; a blaze of scarlet unbroken by tree or hedgerow. Here and there long stretches of chamomile (*Matricaria Chamomilla*, L.) broke into the prevailing red and monopolised some acres; and large patches of yellow charlock were also conspicuous, but in the general effect no other plants were noticeable, though a closer inspection revealed the presence of most of the common weeds of cultivation, a list of which is given below.

Charlock not only occurred in broad patches, but was also fairly uniformly distributed, though masked by the taller poppies. Numerous small patches were, however, conspicuous, and these usually marked the more recently dug graves of men buried where they had fallen. No more moving sight can be imagined that this great expanse of open country gorgeous in its display of colour, dotted over with the half hidden white crosses of the dead. In no British military cemetery, large or small, however beautiful or impressive it may be, can the same sentiments be evoked or feelings be so deeply stirred. Nowhere, I imagine, can the magnitude of the struggle be better appreciated than in this peaceful poppy-covered battlefield hallowed by its many scattered crosses.

The woodland areas afford a striking contrast and are a melancholy sight, being a collection of battered and burnt stumps. Sometimes the bare gaunt trunks, showing here and there the stump of a lateral branch, are as much as 20 ft. high, but for the most part they are shattered, torn, and splintered with only a few feet of the bole remaining. In all the woods where the fighting was most severe not a tree is left alive, and the trunks which still stand are riddled with shrapnel and bullets and torn by fragments of shell, while here and there unexploded shells may still be seen embedded in the stems. Aveluy Wood, however, affords another example of the effort being made by Nature to beautify the general scene of desolation. Here some of the trees are still alive though badly broken, but the ground beneath is covered with a dense growth of the Rose-bay Willow Herb (*Epilobium angustifolium*) extending over several acres. Seen from across the valley this great sheet of rosy-pink was a most striking object, and the shattered and broken trees rising out of it looked less forlorn than elsewhere.

A little further back the woods have naturally suffered less severely, and trees that are badly torn and broken gradually become rare. Very occasionally, even in the battle area, a tree in leaf and only slightly injured may be seen, all the more pathetic and mournful in its loneliness especially when surrounded by gaunt and blackened stems, whose shattered, armlike branches seem to be pointing with the hand of fate.

The roadside trees in the battle area have been equally destroyed, and in many cases they have been deliberately felled. It was interesting to notice that in a few cases the battered trunks were sprouting both from the stem and from the base, and in almost every case the sprouting trees were elms; very rarely were signs of life shown by poplars.

The innumerable shell-hole ponds present many interesting features to the biologist. In July they were half full of water, and abounded in water beetles and other familiar pond creatures, with dragon flies flitting around. In nearly every shell-hole examined, just above the water level, was a band of the annual rush (*Juncus bufonius*, var. *gracilis*), and this plant appeared to be confined to these annular bands where the ground was relatively moist, and to occur nowhere else. With the *Juncus*, and often growing out of the water, were stout plants of Persicaria (*Polygonum Persicaria*) and water grasses, not in flower, were often seen spreading their leaves over the surface of the pools.

In the battlefield area not only were the common cornfield weeds to be seen, but here and there patches of oats and barley, and occasionally plants of wheat, sometimes apparently definitely sown, perhaps by the Germans, though more often the plants must have grown from self-sown seeds of crops that were on the land before the war. Here and there, too, could be seen opium poppies representing former cultivation and remnants of battered currant and other bushes which alone remained to show where once had been a cottage garden. Both weeds and corn afford good evidence that the soil has not been rendered sterile by the heavy shelling, but how and when the land can be brought into a fit state for cultivation are questions not easily answered. Even were the ground not full of unexploded shells, barbed wire and every sort of obstruction, the levelling of the surface would present an immense problem.

Weathering in course of time will tend to fill the shell-holes and smooth down the separating ridges, but even then ploughing by any ordinary machine would appear to be impossible, and the only solution of the problem may be to convert the battlefield into a forest tract by planting trees as soon as conditions allow, thus forming a "Via Sacra," both beautiful and useful.

The re-surveying of the country and re-apportioning of the devastated land in former villages and open fields, though simple on a map, must for some time be quite impracticable.

One other feature of the flora of this region deserves mention, namely, that of the banks and sides of the roads. In such places traces of the old permanent flora still remain, and perennial plants, such as the purple Scabious (*Scabiosa arvensis*), prickly Eryngium (*Eryngium campestre*), yellow bedstraw (*Galium verum*), Chicory, Hard-heads (*Centaurea Scabiosa*), the dwarf thistle (*Cnicus acaulis*), and other characteristic chalk plants were occasionally seen.

The clothing of this large tract of country with such a mass of vegetation composed almost entirely of common annual cornfield weeds is remarkable when one remembers that it has been the seat of encampments, and has for the most part been out of cultivation since the autumn of 1914. It is well nigh impossible

that such masses of seed can have been carried by wind or birds to cover these thousands of acres, and the plants must therefore have grown from seed lying dormant in the ground. No doubt in the ordinary operations of ploughing and tilling of the ground in years before the war much seed was buried which has been brought to the surface by the shelling of the ground and subsequent weathering. In this connection the presence of charlock on the more recently dug graves, where the chalk now forms the actual surface, is of interest, since it adds further proof of the longevity of this seed when well buried in the soil.

Further north towards Arras, where the soil is deeper, docks, thistles, and a more permanent wild vegetation predominate, giving a dreary and derelict effect in comparison with the splendour and magnificence of the chalky slopes of the Somme battlefield.

List of Plants.

The following is a list of plants observed on two brief visits to this area. A few common docks and thistles occurred in places, otherwise the vegetation was almost entirely composed of annuals; grasses of various kinds were also present, in addition to scattered plants and patches of cereals, but the species were not definitely determined.

Papaver Rhoeas, L., poppy.
Fumaria officinalis, L., fumitory.
Raphanus Raphanistrum, L., white charlock.
Brassica Sinapis, Vis., yellow charlock.
Matricaria Chamomilla, L., chamomile.
Centaurea Cyanus, L., cornflower.
Cnicus arvensis, Hoffm., thistle.
Sonchus arvensis, L., corn sowthistle.
Sonchus oleraceus, L., sowthistle.
Specularia Speculum, A. DC., looking-glass flower,
Anagallis arvensis, L., scarlet pimpernel.
Myosotis arvensis, Hoffm., forget-me-not.
Convolvulus arvensis, L., small bindweed.
Solanum nigrum, L., nightshade.
Plantago major, L. and other species, plantain.
Veronica hederaefolia, L. and other species, speedwell.
Galeopsis Ladanum, L., hemp-nettle.
Chenopodium album, L., goosefoot.
Atriplex patula, L., orache.
Polygonum aviculare, L., knotgrass.
Polygonum Persicaria, L., persicaria.
Rumex obtusifolius, L., dock.
Euphorbia Helioscopia, L., sun spurge.
Mercurialis annua, L., dog's mercury.
Juncus bufonius. L., var. *gracilis*, St. Amand, rush.

A few grasses and occasional plants or patches of oats, barley, and wheat.

A. W. H.

XXX.—THE HIMALAYAN SPECIES OF SKIMMIA.

J. S. Gamble.

For some years I have been under the impression that the plant described in the Flora of British India I. p. 499 (1875) as *Skimmia Laureola* contained more than one species, because, in addition to the well-known undershrub of the Western Himalaya, barely 2-3 ft. high with pale yellow flowers and red berries, I found in the Eastern Himalaya one which grew into a small tree and had nearly white flowers and black berries, while at high levels also in the Eastern Himalaya there seemed to be a third, a quite low trailing shrub also with whitish flowers and (so far as I know) greenish rather dry berries. I have for a long time intended to find out more about these plants and I have now been induced to go into the question by having received from Mr. C. C. Lacaita, F.L.S., who made an expedition to the mountains of Sikkim in 1913, with the request to name them, specimens of those he collected on his tour. I have now gone through the whole of the material in the Herbarium at Kew and compared with it Mr. Lacaita's specimens as well as those which I myself collected at various times when on forest work both in the Western and Eastern Himalaya.

Apparently, the first specimens collected were those obtained by Wallich in Nepal in 1821 and issued as Cat. 6357A. It would seem that it was on these specimens that De Candolle in 1824 based his *Limonia? Laureola*, DC. Prodr. i. p. 536. The description is very brief, "foliis simplicibus, floribus terminalibus corymboso-capitatis. Folia exacte *Daphnes Laureolae*. Calyx 5-partitus. Petala et stamina 5." De Candolle's description was followed in 1832 by the very full one of Wallich himself with plate quoted as *Limonia Laureola*, Wall. in Pl. As. Rar. p. 23, t. 245 (1832). The plate gives an excellent representation of the flowering stage of the common species of the Western Himalaya, except that the leaves are shorter and not so oblanceolate as in most of the specimens I have seen either wild or in gardens or as Herbarium specimens. Still, I cannot doubt that Wallich's figure is intended to represent the Western Himalayan plant with pale yellow flowers and dense short terminal flowering panicles. The leaves are given as 3-5 in. long which is correct, and the chief point of discrepancy in the description is that the fruits are described as being almost as large as those of the olive which is a larger size than suits any of the Himalayan Skimmias. The specimens quoted in Wallich's description are (1) his own from Nepal, apparently Cat. 6357A, collected in 1821, (2) specimens collected by Dr. G. Govan in Sirmore, probably Wall. Cat. 6357B, and (3) specimens collected by Blinkworth in Kumaon which I have not seen.

The next description is that by Decaisne in Jacquemont's "Voyage Botanique," quoted *Anquetilia Laureola*, Dcne. in Jacq. Voy. Bot. p. 161, t. 161 (1844). He describes a shrub about a metre high, the stems erect, rooting below and with ashy bark; leaves 10 cm. long, 2-2·5 cm. broad, oblong lanceo-

late; flowers pale yellow in a densely-flowered panicle; berry red; and his description and figure clearly represent the West Himalayan plant. The specimens were collected at high elevations in the "Pir Panjal between Ilahabad and Haiderabad."

The same plant is referred to in Roemer's Synopsis as *Laureola fragrans*, Roem. Syn. I. 74 (1846), and it was then transferred to *Skimmia* as *Skimmia Laureola*, Sieb. & Zucc., MSS. in Walp. Rep. V. p. 405 (1845-46). This seems to have been overlooked by Sir Joseph Hooker, who gives it as *Skimmia Laureola*, Hook. f. in Fl. Br. Ind. I. p. 499 (1875). Sir Joseph had before him, belonging to Indian species of *Skimmia*, not only the specimens from the West and Central (Nepal) Himalaya referred to by previous authors, but also specimens from the Eastern Himalaya collected even so far to the east as the Mishmi Hills and also in the Khasia mountains of Assam. I have carefully examined all the available material, and so far as I can make out the plant described and figured by Wallich and Decaisne has only been collected in the Western Himalaya. All the material from the Eastern Himalaya is distinct from that of the Western region and falls in my opinion into two sections:—(1) A small tree or large shrub with thick woody stem, white or greenish-white flowers in terminal panicles 2 in. or more long, oblong or oblanceolate leaves up to 8 in. long, long acuminate at apex, rather thin, prominently nerved and with long petioles, and black berries found at elevations of about 6000 to 8000 ft., and (2) a very low, rather trailing bush, the stem rooting below, leaves at most 2·5 in. long with prominent midrib and obscure nerves, flowers in rather few-flowered often axillary panicles apparently white and small greenish berries. No. (1) was recognised by Dr. T. Anderson in a note on his sheet in the Kew Herbarium "No. 51, 6500 ft. alt., May, 1862, as a species *Skimmia arborescens*, T. And., but it was apparently never published. No. (2) was apparently recognised by Sir Joseph Hooker as a species and called *S. Wallichii*, Hook. f. & Thoms. on a sheet of Wallich's collected in Nepal in 1821. This name also does not appear to have been published. The specimens in the Kew Herbarium show the much more open and fewer-flowered inflorescence and the acute to caudate-acuminate small leaves with short petioles and conspicuously keeled midrib. It was also collected by Hooker himself in Sikkim (No. 94 Tonglo top, 10,000 ft.; Singalilah 11,000 ft.; Lachoong 9000 ft.); and by Griffith in Bhutan (Nos. 1810, 1811). I have given diagnoses of the characters of these two East Himalayan species in a note appended to a paper by Mr. C. C. Lacaita in the Linnean Society's Journal, vol. xliii. p. 491.

Part iv. of the "Plantae Wilsonianae" appeared in 1914 with Rehder & Wilson's description of the Western China Skimmias, two species (1) *S. melanocarpa*, under which was quoted, besides Chinese specimens, Sir Joseph Hooker's Sikkim plant which I have above referred to as *S. arborescens*, T. And. MS., and (2) *S. Fortunei*, Mast. At the suggestion of Mr. C. C. Lacaita, I have again looked up the specimens at Kew and am glad to find that most of Wilson's numbers have been received and incorporated. The type of *S. melanocarpa* is *Wilson* 1054,

a small shrub with rather small leaves which, in my opinion, is not *S. arborescens*, T. And., but, if anything, is nearer *S. Wallichii*, Hook., f. & Thoms. Of the other numbers of Wilson's and Henry's specimens quoted, *Henry* 10469, 11200, 11069, also but not quoted 10546, 11426, 13328 belong to a large shrub with larger leaves and black fruit which probably really is *S. arborescens*, T. And. In Rehder and Wilson's description, *S. melanocarpa* is described as "0·3-1 m. altus," but in brackets they have added "planta yunnanensis interdum ad 5 m. secundum Cl. Henry." The statement in brackets refers to the *Henry* numbers above quoted, which I believe to belong to *S. arborescens*. It seems clear to me, now, that the Sikkim plant is *not* the type *melanocarpa*, but should continue to bear Anderson's name. So that, in my opinion, Rehder and Wilson's *S. melanocarpa* includes two species, a thin small-leaved low shrub which is real *S. melanocarpa* and which seems not to occur in the Himalaya, and the large big-leaved shrub of Yunnan which is probably the E. Himalayan *S. arborescens*.

XXXI.—NATURAL GRAFTING OF BRANCHES AND ROOTS.

W. Dallimore.

(With Plates.)

Natural grafting of branches and roots is of common occurrence amongst certain species of trees and shrubs, and the results are sometimes very curious, not only by reason of the complicated character of the unions between branches or roots of individual trees, but also by the joining together of large branches and even trunks of different trees of the same species.

Naturally-grafted branches are fairly common on beech, oak, holly, lime, willow, yew, and Scots pine, whilst they may also be noted on many other trees. The commonest form of natural grafting is that which results from the crossing of two branches. When young and light such branches are easily moved by wind, and the friction thus caused injures the bark, first by polishing the surface, afterwards by fracture. Later on the wood may also be injured, for, as the branches grow older and heavier, the easy, gliding action of one branch upon the other gradually gives place to a slower but more injurious grinding movement which may cause considerable injury and deformity, the affected surfaces losing their roundness and one or both branches becoming worn to a mere shell. During the whole of the time, however, nature is trying to repair the injury and patches of callus are formed on both branches at those points where friction is least active. As the branches become heavier and movement ceases the patches of callus grow together and eventually a strong union is effected between the two branches. A series of specimens in the Forestry Museum at Kew show quite well how such a union is brought about.

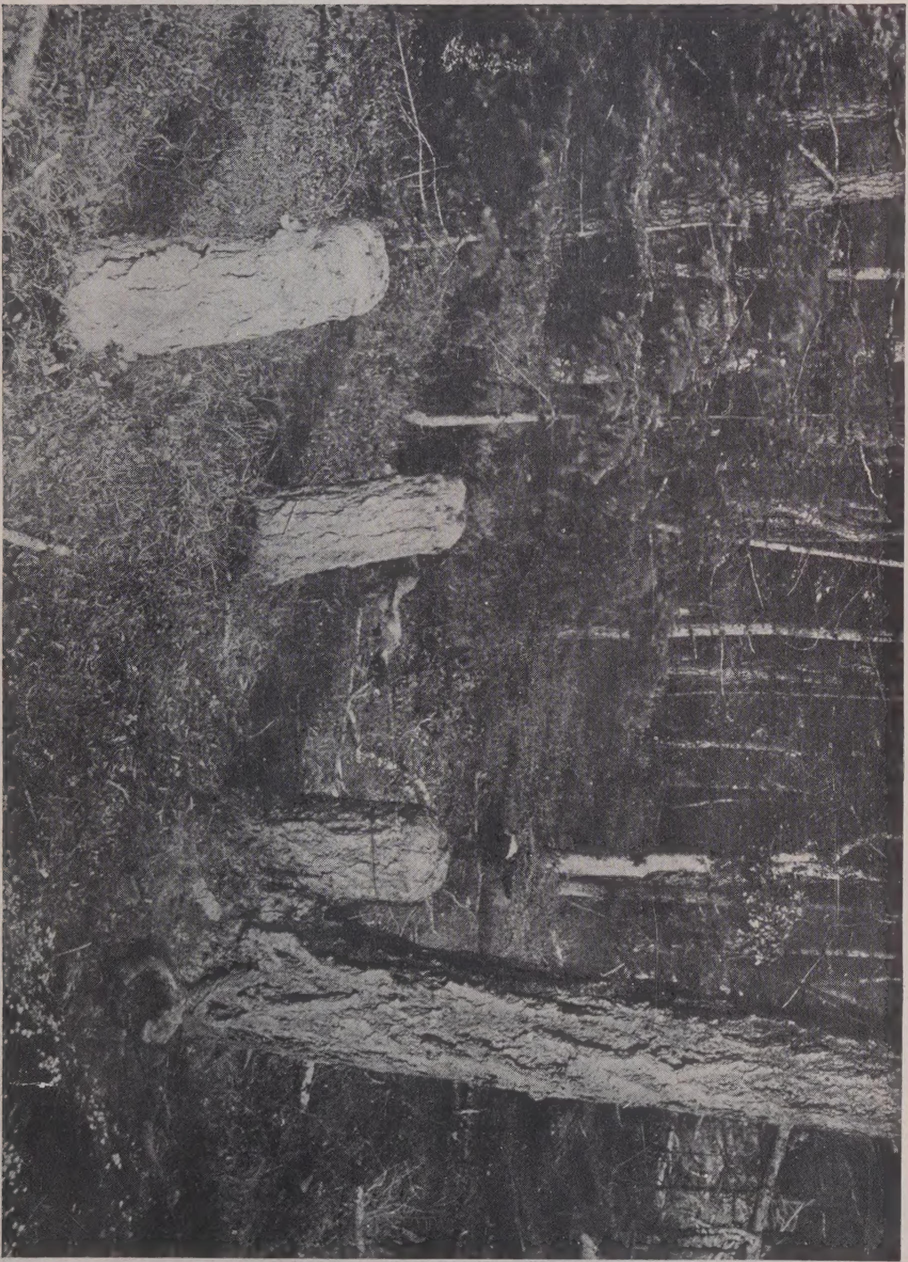
Another fairly common method of natural grafting of branches

is brought about by a side branch from a principal branch or from the leading shoot of a tree growing against another branch or a rival leader. In such a case there may not be sufficient friction to seriously injure the bark, but there may be considerable pressure and the small branch may cause a certain amount of constriction to the larger one in the same way that tightly tied string or wire does, except that the pressure is on one side only. The bark above and below, therefore, grows faster than the constricted part, with the result that the small branch is gradually overgrown in the same way that a string or wire may be completely buried in the wood, or a stone pressed tightly against the bark of a young tree may be overgrown. But in other cases there may be enough friction to injure the bark and expose the cambium. Then a union is brought about by fusion of callus formed at the point of injury. In either case it is easy to see in the early stages what has happened, but later on the end of the small branch may die and fall away, the point of union being completely overgrown by the main branch. As a result there is a small branch, to all appearances alive and healthy, perhaps from a few inches to several feet long, uniting two branches or two trunks in such a way that it is difficult to decide from which branch the connection originated. A few years ago, when visiting Scotland, I was shown two large Scots pines standing a few feet apart which were united by such a branch at a point 12-15 feet from the ground, the connecting branch being almost horizontal and appearing to grow from about the centre of each trunk. Two beech trees are joined in the same way on the Ashridge Estate, Berkhampstead, and a photograph has been recently received from British Columbia showing two trees connected by a branch at a considerable distance from the ground.

A curious instance of natural grafting of beech may be seen in the Forestry Museum at Kew. A small side branch after growing for about 8 inches, crossed the parent branch and became united. The end of the small branch died and no trace of grafting can now be seen on the bark. At its greatest distance from the parent branch it is $1\frac{1}{4}$ inches, thus forming a handle by which the specimen can be conveniently carried. Modifications of this style of natural grafting may often be noticed and a branchlet may grow several feet away from the parent branch and then gradually return and join again at a point higher up the branch.

Natural grafting is also effected by a branch growing through the acute angle formed by two fairly erect branches. In such a position there is little movement and the small branch is soon overgrown by the large ones.

A transverse section of timber may show two or even three or more hearts. This may be due to the union of a secondary leader with the true leader, or several leaders may become involved, but it does not appear to hold good in every case. In some instances the appearance of the timber suggests that the union of two or more shoots has been complete from infancy. In elm trees two or more hearts may often be found in a section of the timber especially if the section is taken from a point



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higher than the middle of the trunk. Several hearts are often found in a transverse section of yew wood. In yew, however, the condition is usually due to erect stems formed at the base of the main trunk being overgrown by the trunk, but now and then natural grafting is in evidence.

Whenever a large tree is felled, evidence of root grafting is found, for, as the roots of trees growing close together become intermixed with those of the same species, and sometimes of allied species, they easily unite. Pressure is probably responsible in most cases for root grafting, and very curious results are sometimes seen, although, obviously, grafted roots attract less notice than grafted branches. Roots growing amongst close gravel or in clay and chalk often present a very curious appearance not only by intergrafting, but by deformity caused by the rough edges of stones and by their growing round and enclosing stones.

Whether trees actually benefit to any great extent from this natural intergrafting of roots or branches is doubtful, for there can be no discrimination of stocks and scions which makes propagation by grafting of such importance to the horticulturist, but that some local benefit may result is seen occasionally, more particularly by a branch of a weak or unhealthy tree which has become united to a healthy tree, being more vigorous than the other branches.

An interesting series of photographs, three of which are published with this article, has recently been received at Kew from PRIVATE C. C. PEMBERTON, of Victoria, British Columbia, now with the Canadian Army. They represent a series of studies in the natural grafting of roots and branches as seen in the forests of British Columbia, together with other interesting conditions of tree growth. The branch grafts are varied in character, but similar ones are of fairly frequent occurrence. Amongst the root grafts, however, a particularly interesting condition is represented. This is the healing under certain circumstances of the cut surfaces of Douglas fir and *Abies grandis* stumps when cut over at a height of 1-2 feet above the ground. Mr. Pemberton makes no pretence to sylvicultural or botanical knowledge, his observations having been conducted solely by reason of his love of nature. The healing of branchless stumps appealed to him as being something apart from the ordinary behaviour of trees, and he set to work to find a reason. By baring the tree roots over a considerable area of ground he was able to satisfy himself that every stump that had healed or was well advanced towards that state was attached by root grafting to a standing tree with healthy foliage, and further, that by cutting down the living tree the stumps were killed within a short time. He noticed further that the roots of decaying or dead stumps were rarely attached to the roots of a living tree.

The phenomenon has been previously noticed and is referred to by Sorauer, Handbuch der Pflanzenkrankheiten, Berlin, 3rd ed., 1909, vol. i. p. 774. The views there expressed coincide largely with the observations made by Mr. Pemberton, for the theory is favoured that the healed stumps obtain nourishment

by means of the concrescence of their roots with strong roots of neighbouring trees which still possess a trunk and crown. The author, however, does not consider that this is always so, for he instances cases of healed stumps standing too far away from living trees for the roots to have any connection. To some extent he favours the idea of reserve material stored in cut over stumps accounting for the commencement of new growth, but once a callus is started he thinks that further growth may be stimulated by chlorophyll present in the cortex of the callus, more particularly when the stump is in a light and open position.

So far as Mr. Pemberton's observations go, however, and he has paid a good deal of attention to the subject, he has been unable to find a single instance of the healing of a stump that is unattached to the roots of a tree bearing healthy branches. Should he be able at some future time to extend his studies it would be interesting to learn whether he finds any other indication save natural grafting that would account for the phenomenon.

Natural grafting in its various phases holds peculiar attractions for people interested in tree life, and the subject is well worthy of attention by people who have the necessary time at their disposal.

Explanation of Plates.

1. Healed stumps of Douglas fir (*Pseudotsuga Douglasii*).
2. Two trees of Douglas fir showing the connection of roots above ground.
3. Naturally-grafted roots of *Abies grandis*.

XXXII.—THE NATURE OF CHARRED WOOD.

L. A. Boodle.

The blackening of organic matter by heat or by the action of sulphuric acid is generally described as carbonisation, and the use of this term implies the presence of free carbon in the blackened product. In wood-charcoal obtained by heating in the usual way, the percentage of carbon present varies with the temperature employed for charring. Thus it is stated that charcoal produced at 249° C. contains 65 per cent. of carbon, and that temperatures of 399° C. and 1499° C. give charcoals with 80 and 96 per cent. of carbon respectively. Ordinary charcoal is known to contain oxygen, hydrogen and a little nitrogen, besides carbon and the constituents of the ash. One might suppose, therefore, that the charcoal prepared at 249° contains free carbon, as well as a considerable proportion of some compound of carbon, hydrogen and oxygen, and that the blackness of the material depends on the presence of the free carbon.

Some experiments recently made with charred wood have a bearing on this subject, and, though they were quite simple and unaccompanied by any chemical analysis, they gave some suggestive results.

The material used in the experiments consisted of wood (in most cases Pine), charred either by sulphuric acid with heat, or by heat alone, and in both cases some variation was introduced into the conditions under which carbonisation took place. The black substance obtained was first powdered, and then each sample was submitted to two tests, namely, boiling for a short time in eau de Javelle, and boiling for two minutes in nitric acid (pure, 1·42), to which some chlorate of potash had been added. Samples of typical charcoal were also treated in the same way, and were found to be resistant to both these re-agents.

Treatment with sulphuric acid was carried out as follows:— A small piece of wood was soaked or boiled in diluted sulphuric acid (one part of the acid to six or ten parts of water), and the specimen, after its surface had been dried, was then heated in an oven.

In two experiments pieces of wood, which had been previously boiled in dilute sulphuric acid, were heated gradually to 160° and 200° C. respectively. The product in both cases was similar in appearance to ordinary charcoal, but was found to be soluble in the nitric acid re-agent.* Further, the substance obtained at 160° was soluble in eau de Javelle, except for a very small residue, while the specimen prepared at 200° was only slightly attacked by this re-agent. Blotting paper similarly treated became blackened, and behaved towards the re-agents in the same way as the charred wood.

Other experiments (without the use of sulphuric acid) were made to supplement the tests applied to typical charcoal. Wood was heated cautiously over a small flame, using either a small piece of wood on mica, covered by a watch-glass, or a thin layer of sawdust between two sheets of mica. Heating was stopped almost as soon as the wood became quite black, or was continued longer. In the latter case a typical charcoal was obtained, insoluble in the nitric re-agent, while less heating gave a product soluble in this re-agent, and probably corresponding to a low-temperature charcoal. Among the specimens obtained, those soluble in the nitric re-agent were either partially soluble in eau de Javelle, or were insoluble, according to the duration of the heating used to produce their carbonisation.

The foregoing data show that wood can be charred so as to give a product which differs from typical charcoal in its behaviour towards oxidising agents. Moreover, a series of degrees of resistance to these re-agents can be obtained, and evidently bears a relation to the severity of the charring process.†

It remains to be seen whether all "charcoal" produced at a relatively low temperature will be soluble in the nitric reagent, and whether the series of "charcoals" prepared by heat alone can be completed by obtaining a specimen entirely soluble

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* In some cases the product was treated with ammonia and soaked in water, to remove the remaining sulphuric acid, before being tested with the two re-agents.

† Treatment with dilute sulphuric acid and heat owes its effect primarily to the concentration of the acid by the loss of water, but the action of the acid is apparently enhanced by heat at certain temperatures.

in eau de Javelle. The lack of a convenient arrangement for heating at the requisite range of fixed temperatures has postponed the necessary experiments.

The fact that certain specimens of charred wood are completely soluble in the nitric re-agent, and some even in eau de Javelle, leads to the conclusion that in such cases either no free carbon is present, or, if there is any uncombined carbon, it must be in a different state from that in which this element occurs in typical charcoal. The first of these assumptions appears the more probable, and it may be supposed that a "charcoal" soluble in these re-agents consists throughout (apart from ash, etc.) of a black organic compound of carbon, hydrogen and oxygen. It is suggested further that different stages of carbonisation may involve the production of at least two black organic compounds, one soluble in eau de Javelle, and one insoluble in it, but dissolved by the nitric re-agent. The more resistant substance would be derived from the other by a further loss of hydrogen and oxygen, and incomplete conversion into the more resistant compound would be indicated by *partial* solubility in eau de Javelle.

In the cases of partial solubility in eau de Javelle observed in the experiments mentioned above, the residue was black. Slighter charring with acid can, however, give a product in which there is apparently merely a fractional conversion of the woody tissue into a black compound. Thus in two experiments, pieces of wood treated with sulphuric acid were heated for one hour at 78° and 104° C. respectively. The first specimen was brownish-black, and not brittle, while the second was fairly similar to typical charcoal. The product in both cases was bleached by eau de Javelle, and was not largely soluble in this re-agent.

Useful advice on several points was kindly given by Dr. P. Haas, and is gratefully acknowledged.

XXXIII.—FUNGI EXOTICI: XXIII.

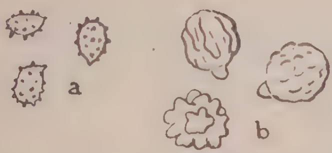
E. M. Wakefield.

The present contribution includes eight species of fungi which are either known to be parasites or are suspected of parasitism. Three of them, *Polyporus Coffeae*, *Helicobasidium longisporum*, and *Cercospora cannabina* occur on economic plants, and may prove to be of some importance. The parasitism of the two former is not proven, but it is possible that the *Helicobasidium*, at least, may be capable of causing some injury. Fortunately at present these are the only specimens which have been reported.

Polyporus Coffeae, *Wakef.*

Fungus mesopus. *Pileus* carnosus, irregularis, nunc lobatus nunc undulatus, vegeto cremeo-albidus, sicco alutaceus, adpresse subtomentosus, azonatus, ad 15 cm. diametro. *Contextus* concolor vel isabellinus, centro ad 3 cm. crassus, marginem versus

tenuior. *Tubuli* obscuriores, tenuissime tunicati, 2·5-7·5 mm. longi. *Pori* subhexagoni, 1-2 mm. diametro, sicco collapsi,



a. Basidiospores. b. Conidia from root of coffee tree. × 850.

sordide brunnei. *Stipes* excentricus, 5-8 cm. longus, basi 2-2·5 cm. crassus, sursum incrassatus. *Sporae* copiosae, stramineae, aculeatae, 5-6 × 4 μ (cum aculeis).

TROPICAL AFRICA. Uganda; at the roots of a dead Coffee tree, Kampala, *W. Small* 327 (1915).

The fungus belongs to the section *Spongiosus* of *Polyporus*, and is near to *P. rufescens*, from which it is distinguished by its larger size and aculeate spores. It is under suspicion of having caused the death of the tree. The fructifications were found surrounding the collar of the plant, the roots of which were encrusted with a layer of white mycelium mixed with sand. On this crust of mycelium there occur patches of a conidial fructification which may be connected with the *Polyporus*. The conidial layer is chestnut-brown, pulverulent. The conidia are stalked, subglobose, sometimes with a hyaline apiculus at the apex, coarsely warted, the warts arranged more or less in lines running from apex to base of the spore, 8-10 μ in diameter.

Amauroderma infundibuliforme, *Wakef.*

Fungus rigidus, mesopus, circa 17 cm. altus. *Pileus* infundibuliformis, margine involuto, sublaccatus, fusco-pruinosus, sicco fortiter rugulosus, marginem versus leviter zonatus tuberculatusque, 10-14 cm. diametro. *Contextus* albidus vel alutaceus, fibrosus, lineis atris paucis percursus. *Tubuli* lignicolores, contextu obscuriores, 2-3·5 cm. longi. *Pori* minuti, vegeto purpurei, sicco grisei, crasse tunicati. *Stipes* centralis, aequalis, vegeto laccatus, sicco pruinosus, olivaceo-brunneus, 12 cm. longus, 1·5 cm. diametro. *Sporae* subglobosae, laeves vel minutissime punctatae, pallide brunneae, 10 μ diametro.

TROPICAL AFRICA. Uganda: Bumpenge Forest; on the ground beneath a dead tree, *T. D. Maitland* 24A (1915).

A very distinct species, marked by the infundibuliform pileus and the hard smooth crust, which when fresh is distinctly laccate, but when dry becomes dull and greyish or olive-brown. Most of the sporophores have grown closely adpressed to the trunk and therefore are not symmetrical.

Hexagonia subvelutina, *Wakef.*

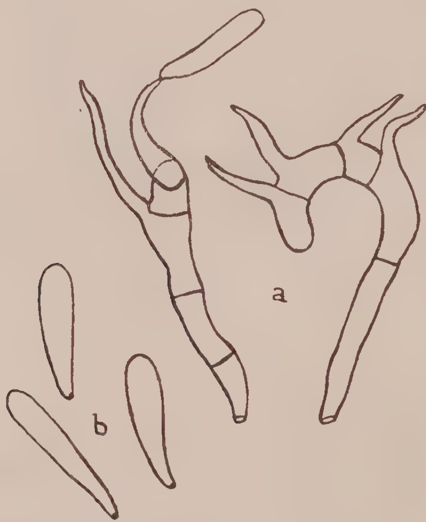
Pileus dimidiatus vel pseudo-stipitatus, lobatus, rigidus, concentrice zonatus, radiatim adpresse strigosus, postice leviter tomentosus, lignicolor, 5-10 cm. diametro, ad 1-1·5 cm. crassus. *Tubuli* ad 3 mm. longi, intus glaucescentes. *Pori* angulati, 2-3 mm. diametro. *Sporae* non visae.

Tropical Africa. East Africa Protectorate; on wood, *W. J. Dowson* 530 (1916).

The specific name is chosen to indicate its close relationship to *H. velutina*. It is distiguished from that species by the much larger pores, thicker substance, and strigose pileus. From *H. rigida*, Berk. it differs in the velvety covering towards the base of the pileus.

Helicobasidium longisporum, *Wakef.*

Sporophorum effusum, pulverulentum, purpureum. *Basidia* uncinata, 4-6-septata, 1-4-sterigmatica, 5-7 μ diametro, demum



a. Basidia. b. Spores. $\times$ 850.

purpurea. *Sterigmata* 10-25 $\times$ 2-3 μ. *Hyphae basales* purpureae, 5-5·5 μ crassae, septatae, non nodosae, laxe intertextae.

Tropical Africa. Uganda; on roots of *Theobroma Cacao*. *W. Small* 463 (1917).

This is distinguished from all other known species of *Helicobasidium* by the long, coloured spores. The colour of the hymenium is between "livid purple" and "naphthalene violet" of Ridgway's colour standards.

The affected roots show internal mycelium, especially along the medullary rays. Mr. Small states that he is inclined to regard the fungus as a parasite.

Tilletia Wilcoxiana, *Griffiths* in Bull. Torr. Bot. Club, xxxi., 1904, p. 88.

A specimen of *Stipa eminens* var. *Andersonii*, Vasey, from Santa Catalina Island, California, preserved in the Kew Herbarium, shows what is undoubtedly the mature state of this fungus, which was described from immature material. The host plant and the external characters of the smut agree with the description of *T. Wilcoxiana*. As to the spores, however, the following amended description is necessary:—

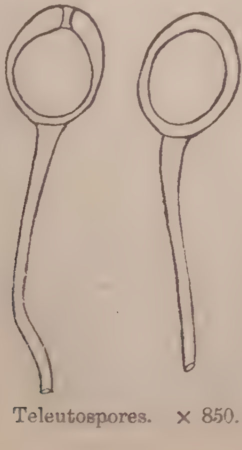
Spores cinnamon in the mass, pale yellow to clear pale cinnamon by transmitted light, very thick-walled. The spore-wall consists of three layers. The outer wall is very thin, hyaline, and apparently of a slightly mucilaginous nature, as it swells slightly and therefore becomes more visible by the action of potassium hydrate. The inner wall is also very thin. Between

Mature spores. × 850.

them is a thick middle wall, brownish in colour, and sculptured in a reticulate manner. The main ribs of the reticulum are arranged more or less spirally, and are connected by much smaller and less distinct cross ribs. In optical section the thickenings give the effect of coarse warts at the circumference of the spore. The mature spores are 18-20 μ diameter, the total thickness of the wall being about 2-2·5 μ.

Uromyces Secamones, *Wakef.*

Sori teleutosporiferi hypophylli, umbrini, firmi, pulvinati, 0·5-0·75 mm. diametro, interdum confluentes, maculis indistinctis ad 3 mm. diametro circinatim dispositis. *Teleutosporae* brunneae, laeves, subglobosae, ellipsoideae, vel subclavatae, apice



Teleutospores. × 850.

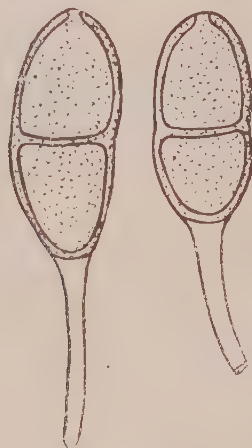
rotundatae, incrassatae, 19-23 × 17-19 μ, rarius majores, verticaliter septatae, 20-22 × 25-30 μ.

TROPICAL AFRICA. Uganda; on leaves of *Secamone platystigma*. *R. Dummer* 3012 (Oct., 1916).

This species differs from *U. Howei*, Peck, in the smooth teleutospores. The occasional large, vertically septate spores form a connecting link with the genus *Diorchidium*, but the majority of the spores are typically those of *Uromyces*.

Puccinia Hoheriae, *Wakef.*

Sori teleutosporiferi hypophylli vel caulicoli, sparsi, rotundati vel oblongi, saepe confluentes, epidermide lacerato cincti, castanei, 0·5-1 mm. diametro, maculis parvis atro-purpureis insidentes. *Teleutosporae* ellipticae vel oblongae, medio vix con-



Teleutospores. × 850.

strictae, apice rotundatae non incrassatae, brunneae, episporio minute punctato-granuloso, 35-40 × 15-17 μ; pedicelli hyalini, decid i, 30-80 μ longi.

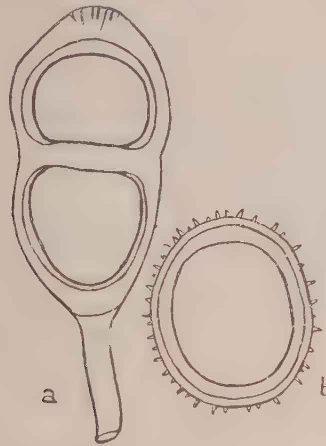
NEW ZEALAND. On leaves and stems of *Hoheria populnea* ("Lacebark"), *A. H. Cockayne* (1917).

Near to *P. Plagianthi*, McAlp., but distinguished by the smaller spores, with granular (not reticulate) epispore. From *P. Abutili* it differs in the narrower spores with more finely granular epispore.

Puccinia Berkheyae, *Wakef.*

Sori epi- vel hypophylli, minuti, sparsi. in maculis parvis flavidis rotundatis vel irregularibus saepe confluentibus singulatim dispositi. *Sori uredosporiferi* cinnamomeo-brunnei, epidermide diutius tecti, demum epidermide fisso cincti. *Uredosporae* brunneae, globosae vel subglobosae, aculeatae, poris germinationibus tribus instructae, 25-30 μ diametro. *Sori teleutosporiferi* minuti, pulvinati, atro-brunnei. *Teleutosporae* oblongae vel clavatae, medio constrictae, apice valde incrassatae, attenu-

atae, rotundatae, brunneae, episporio minute granuloso, 50-62 × 24-30 μ; pedicelli hyalini, decidui, 50 × 4-5 μ.



a. Teleutospore. b. Uredospore. × 850.

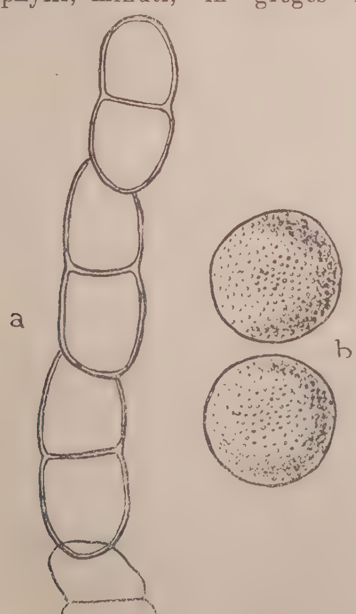
Tropical Africa. Uganda; on leaves of *Berkheya Spekeana*, *R. Dummer* 2752 (Dec., 1915).

Pucciniosira Dissotidis, *Wakef.*

Aecidium Dissotidis, Cooke in Grevillea, x, 1882, p. 124.

Uredo Dissotidis, Cooke, loc. cit.

Maculae distinctae, aridae, pallide brunneae, 1-2 mm. diametro. *Sori* hypophylli, minuti, in greges rotundatos arcte



a. Portion of a chain of Teleutospores. b. Two Aecidiospores. × 850.

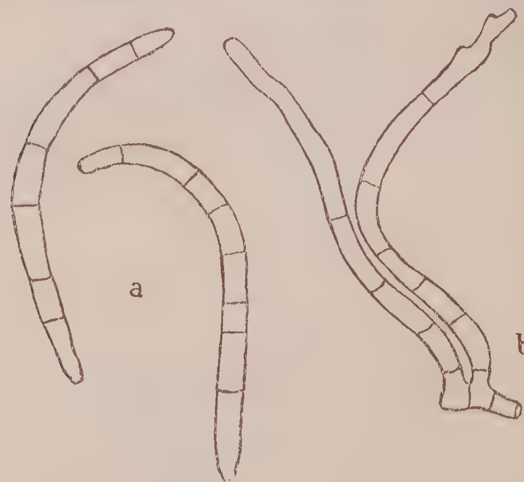
dispositi. *Aecidia* minuta, cupuliformia, pseudoperidio albido margine crenulato cincta. *Aecidiosporae* globosae, hyalinae vel stramineae, tenuiter tunicatae, episporio minute denseque granuloso, 20-23 μ diametro. *Uredosporae* non inventae. *Sori teleutosporiferi* firmi, immersi, minuti, sine pseudoperidio. *Teleutosporae* catenulatae, hyalinae vel stramineae, laeves, ellipticae vel oblongae, medio leviter constrictae, tenuiter tunicatae, 1-septate, cellulis demum secedentibus, 30-35 × 14-17 μ.

TROPICAL AFRICA. Uganda; on leaves of *Dissotis incana* and *Dissotis* sp., *R. Dummer* 2157, 2865.

The aecidia described by Cooke as *Aecidium Dissotidis* occur on the same leaves with teleutosori, and on similar spots. There is no doubt that the two forms are connected. In the type material of "*Uredo Dissotidis*," however, only teleutospores and an occasional aecidiospore can now be found, hence Cooke's description cannot be confirmed. This is the only species of *Pucciniosira* for which an Aecidium stage has been described.

Cercospora cannabina, *Wakef.*

Maculae rotundatae vel oblongae, interdum confluentes, pallescentes, 3-10 mm. diametro. *Acervuli* hypophylli, minutissimi, olivacei, dense aggregatae, pulverulenti. *Conidiophora* sim-

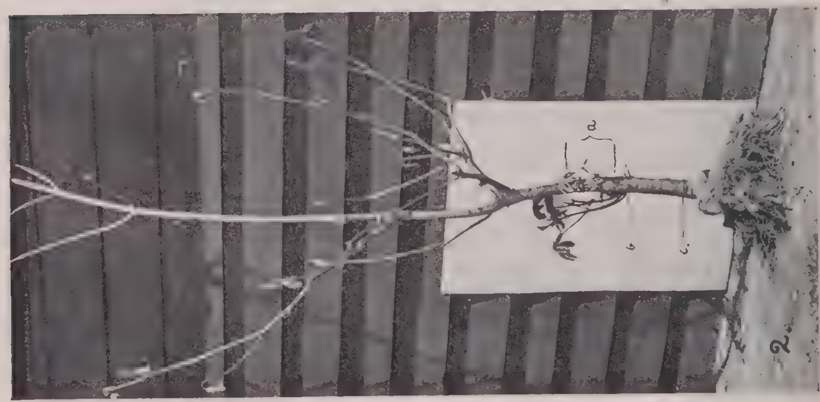


a. Two Conidia. b. Conidiophores. × 850.

plicia, vix fasciculata, septata, olivaceo-fuscidula, 70-85 × 4 μ. *Conidia* curvula, apice rotundata, dilute olivacea, ad 10-septata, 40-90 × 4 μ.

TROPICAL AFRICA. Uganda; on leaves of *Cannabis sativa*, *R. Dummer* 1320 (Dec. 1914).

The conidiophores are erumpent in very small tufts of usually only 4 to 6. Owing to the crowded habit, however, and the long conidiophores and spores, the under-surface of the leaf shows more or less continuous patches of olive tomentum. In this respect the species resembles *Cercospora Odontoglossi*, Prill et Del.



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XXXIV.—ON A TREE OF AESCULUS PAVIA KILLED BY BOTRYTIS CINEREA.

STUDIES FROM THE PATHOLOGICAL LABORATORY: V.

WILLIAM B. BRIERLEY.

(With Plate.)

On May 28th a young specimen of *Aesculus Pavia* growing in the Royal Botanic Gardens, Kew, was observed to be in an unhealthy condition. The leaves were thoroughly wilted and the tree was apparently suffering from the effects of extreme drought. Several specimens of *Aesculus* sp. were standing in the immediate vicinity and as these seemed to be perfectly healthy with turgid extended leaves, a closer examination of the original tree was made. Around the base of the main stem was a circle of bare earth about one metre in diameter, and this soil shewed no appreciable difference in humidity or general appearance from that surrounding the neighbouring trees. About twenty centimetres above the soil surface a circle of new shoots, averaging three to five centimetres in length, sprouted vigorously from the stem. Commencing immediately above these shoots a zone of about ten or twelve centimetres of the bark was slightly shrunken, and sodden or discoloured in appearance; and bore a few immature pustules of *Botrytis* conidiophores. The leaves of the tree were green but hanging in a wilted and limp condition.

Two days later the leaves were no longer flaccid but dry and brittle, and the entire upper portion of the tree was in a desiccated state. The basal shoots were of a dark maroon-purple colour* and growing with extraordinary rapidity and vigour, the longer ones being twenty-three to twenty-six centimetres in length (Pl. vii. Figs. 1 and 2). The diseased region immediately above these showed an abundance of the pale-smoke-grey pustules of *Botrytis*, which obviously coincided with the position of the lenticels in the bark (Pl. vii. Fig. 1, a). Above this region the lenticels were inconspicuous and small, whilst below they were large and tumescent (Pl. vii. Fig. 1, b, c). The diseased tree was about four and a half metres in height and of a moderately strong and vigorous growth. Its age was six years, and the affected region of the stem had a diameter of 4·5 cms. On May 31st the specimen was taken from the ground and photographed (Pl. vii. Figs. 1 and 2).

The diagnosis appeared perfectly straightforward and simple, and the death of the tree was attributed to an invasion of the main stem by *Botrytis*, which, plugging the conducting elements, effectively cut off the water supply to the upper portion of the tree, giving rise to the symptoms of extreme drought. This barrier would cause an excess of food material to accumulate immediately below the diseased region and in consequence the latent or adventitious buds situated here would be stimulated into active development, and a circle of new and vigorous shoots

* All the colour terms used are in accordance with Ridgway, R., "Color Standards and Color Nomenclature," Washington, 1912.

would arise. The deficiency of water in the upper portion of the stem would cause the lenticels to shrivel and become inconspicuous, whilst the excess of water below the diseased region would cause them to become tumescent.

The rapid killing of a large woody tree by the cutting off of food supplies owing to an invasion of the main stem some considerable distance above the soil surface is a sufficiently unusual mode of behaviour for *Botrytis* to make a further examination appear of some interest.

Period of Attack.—One of the striking features in this case is the extreme rapidity with which the upper portion of the tree was killed; and this is made more noteworthy when account is taken of the fact that the wood of *Aesculus Pavia* consists largely of fibres and tracheids, and that although the vessels are comparatively numerous they are of small diameter, and there is little wood-parenchyma tissue. In addition the medullary rays are usually one and rarely more than two cells in width, so that the wood is moderately compact and dense. The development of mycelium even in open woody tissues is usually very slow, and trees attacked by virulent and destructive fungus-parasites not infrequently remain alive for many years, only eventually succumbing to the cumulative effects of the invasion. Similarly in pure cultures of parasitic fungi on wood blocks, the penetrative power of the mycelium in a radial direction is slight, and after a period of several months the hyphae are not usually found at a greater depth than two or three centimetres. In the pure cultures of *Botrytis* upon sterilised blocks of willow and horse chestnut made by Brooks and Bartlett* "the hyphae were seen to have penetrated but a short distance and were only found in those vessels and cells of the medullary rays which were near the surface of the blocks of wood". The slight penetrative power of *Botrytis* in lignified tissues has recently been demonstrated from another point of view by Brown,† for he has shown that the active extract of this fungus, which, when injected into floral structures "produces rotting and death within half an hour" is totally without action on tissues of a hard woody nature. Again woody plants can, as a rule, withstand the cutting through of the greater part of their sap-wood by either artificial or mechanical means, or canker inducing and other fungi, without serious detriment to the immediate condition of their health. In consequence of the above factors the rapid wilting of a tree is only rarely due to fungal attack, and most usually must be attributed to fumes in the soil, extreme drought, or some other factor which affects in a general manner the whole root system. Where it appears that the wilting must be due to fungal invasion, these symptoms imply a remarkable rapidity of mycelial development, and a most unusual thoroughness and completeness of tissue permeation. If the fungus be *Botrytis* as in the present case this would seem even more noteworthy.

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* Brooks, F. T., and Bartlett, A. W.: Two Diseases of Gooseberry Bushes, Ann. Mycol, vol. viii, No. 2, 1910.

† Brown, W.: "The Action of Botrytis cinerea," Ann. Bot., vol. xxix, 1915.

When the tree was first observed on May 28th. the leaves had completed their full expansion after the long winter, and were of normal size and growth, indicating that their development had not been interfered with in any way. They were thoroughly wilted, however, and hung in a limp and flaccid condition. Two days later the upper portion of the tree beginning from the *Botrytis* zone was in a desiccated state, and the leaves were brittle and easily detachable. These symptoms are significant of a very recent cause of drought due to a factor operating in so active and rapid a manner as to form almost immediately a complete barrier to all water conduction in the stem. If the *Botrytis* mycelium in the diseased region is this factor, as appears to be the only probable hypothesis, its behaviour is remarkable.

As the tree was only discovered during the late stages of the fungal invasion the exac. length of time from the primary attack to the death of the host is unknown. A study of the weather conditions during the month of May is, however, instructive. From the 1st of May until May 16th no rain fell at Kew, and the weather was consistently bright and sunny. The temperature was comparatively high, the maximum during this period averaging 20·2° C. and the minimum 6·7° C. From May 16th until May 23rd the weather was dull and showery, 4·19 cms. of rain falling in seven days. The average maximum temperature fell by three degrees, whilst the average minimum increased by three. From May 24th until the end of the month there was a recurrence of the earlier weather conditions with a slightly increased temperature but occasional dull days. Rain only fell on the 29th May when 1 cm. was recorded.

It is well known that the active development of *Botrytis* is peculiarly dependent upon the presence of warm, humid, and equable conditions, and this is especially true of the infection stages. The brief wilting period indicating the unusual rapidity with which the fungus must have developed in the tissues has already been noted. When these factors are borne in mind, and the various phenomena presented by the host tree are correlated with the weather conditions, it appears extremely probable that the primary fungal attack must have occurred during the dull wet week of equable temperature extending from May 16th to May 23rd. This would give a maximum period of fifteen days from the initial penetration of the mycelium or germinating spore to a state of host permeation resulting in the complete desiccation of the tree.

General Distribution of the Fungus in the Host.—In order to determine the degree of penetration of the host tissues by the fungus, the main stem of the tree was carefully divided in a radial longitudinal plane. The diseased area was then visible by reason of its discoloration, and this was greatly accentuated by a few hours' immersion in water (Pl. vii. Fig. 3).

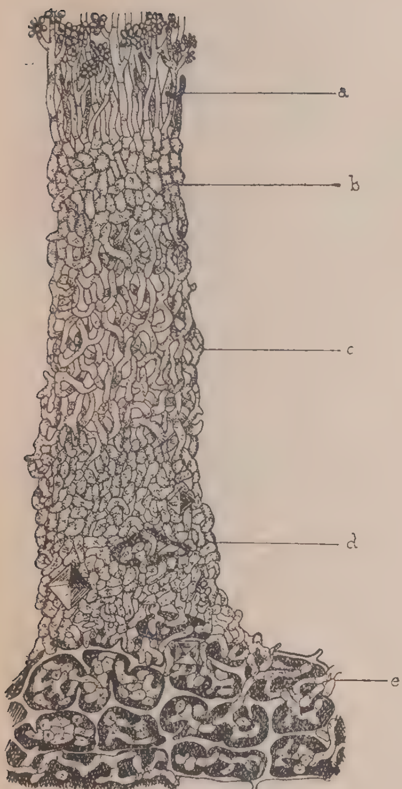
In section the diameter of the affected portion of the stem was appreciably less than that of the non-affected regions, but the most striking distinction lay in the general appearance and

colour of the diseased area. The upper portion of the stem was of a cartridge-buff colour, perfectly dry in appearance, and with a tendency for the tissue elements to tear up. Separating this from the diseased wood and marking the upper extent of mycelial development was a very diffuse olive-buff zone (Pl. vii. Fig. 3, a c a). This merged into the pale-olive-buff of the diseased tissues, which were dull and waterlogged in appearance. The lower limit of fungal growth was sharply defined by a narrow chamois coloured zone extending downward across the wood (Pl. vii. Fig. 3, b d b). The lower healthy portion of the stem contrasted sharply with the tissues above, being bright and richly sappy in appearance and of a marguerite-yellow colour. The diseased region of the cortex was even more sharply defined than the affected wood, for protruding through the collapsed sepia coloured cells were the pustules of *Botrytis* conidiophores. The dry deep-olive-buff coloured cortex above was sharply divided from the dead tissues (Pl. vii. Fig. 3, a) whilst the moist sappy cortex below was of a pale-glass-green colour and bordered abruptly on the diseased cortex (Pl. vii. Fig. 3, b). In addition the latter adhered closely to the wood, whilst the dry cortex above and more especially the healthy cortex below tended to split away from the wood in the plane of the cambium. The demarcation of the affected region has been described in some detail partly because of its distinctiveness, and partly because it shewed in a striking manner that the mycelium of the fungus advanced more rapidly in the woody cylinder of the host than in the cortical tissues (Pl. vii. Fig. 3, a-c, b-d), a result at variance with the experience of previous investigators.

There was no differential discoloration of the wood in transverse section as was found by Brooks and Bartlett in gooseberry bushes attacked by *Botrytis*.

Distribution of the Fungus in the Cortex.—The cortex, bast, and cambium are penetrated in all directions by the mycelium, and a careful examination of the tissues between the healthy and diseased regions, showed that the cells are killed in advance of the actual fungal invasion. In the affected zone the cells lose their content and the cellulose walls become swollen, yellowish in colour and highly refractive. The discoloration and death of the cells occurs before there is any visible effect on the cell-wall. The cell-wall substance is not infrequently finally disintegrated, the middle lamella being the last to disappear, and in the tissues, lacunae are formed which become filled with loosely formed pseudo-parenchymatous masses of mycelium. The relation of the mycelium to the cells of the host, and the nature of the parasitism of the fungus will be discussed in greater detail in a further communication. (Text Fig. 1, e.) It is interesting to compare this with the results obtained by Brown* working with *Botrytis* extract. "It was shewn that the first demonstrable action consisted in the solution of the middle lamella uniting contiguous cells, with the result that coherence of the tissue was destroyed. The attack

* Brown, W. On the Physiology of Parasitism, New Phyt. vol. xvi. 1917.



Text fig. 1.

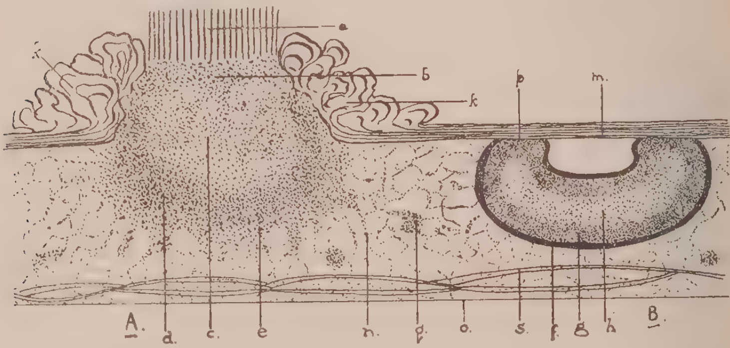
was, however, not confined to this, and the general body of the cell disintegrated, though complete solution of all constituents did not take place. At a comparatively late stage in the process the cells lost their power of becoming plasmolysed in hypertonic solutions. Thus of the two manifestations of the action of the extract, the toxic is subsequent to the enzymic". Blackman and Welsford,* however, found that in the infection of the mesophyll of bean leaves by *Botrytis* "the first morbid change is seen as a slight disorganisation of the protoplast; the swelling of the wall is not noticeable till a later stage". The present results agree very well with those of Smith,† who states that "two different effects must be clearly distinguished, one following the other: first the death of the cells; and second the disintegration of their walls and contents."

In the present case the hyphae were most usually found ramifying abundantly in a loose weft through the disorganised cortical cells, showing no discrimination for an intercellular as distinct from an intracellular course. Under each lenticel in the bark the hyphae mass together forming a pseudo-sclerotial structure which protrudes through the lenticel and resolves itself into a dense cluster of conidiophores (Text Fig. 1 & Pl. vii. Fig. 1, a, Fig. 3, f, g). These stromatic masses usually occupy about two-thirds of the depth of the cortex, are variable in size, and are plainly visible to the unaided vision. They are not sharply defined but are formed by the merging of the cortical-hyphae into a complex of disordered cortical cells and crystals embedded in a mycelial weft. (Text Figs. 1 and 2, e, d.) The centre of this structure is purely hyphal but never forms the solid dense tissue of a true sclerotium (Text Figs. 1 and 2 c). Passing through the lenticel to the outside of the stem this stroma gives rise directly to *Botrytis* conidiophores (Text Figs. 1 and 2, b, a).

* Blackman, V. H. and Welsford, E. J. Infection by Botrytis cinerea, Ann. Bot. vol. xxx. 1916.

† Smith, R. E. The Parasitism of Botrytis cinerea, Bot. Gaz. xxxiii. 1902.

These, and to a certain extent the basal tissues are partially extruded pushing back in all directions the corky tissues of the lenticel. (Text Fig. 2, A, a, b, k.) The conidiophorous-stromata or pseudo-sclerotia are only found in relation to the lenticels and as far as could be determined every lenticel in the diseased region was occupied in this manner (Pl. vii. Fig. 1, a), this probably being the cause of the sodden, water-logged appearance of the affected tissues. Somewhat similar structures have been described on the vine by Istvánffi* and on lime trees by Smith.† In the former case the stromata were considerably more definite in structure, and were very small, being formed under the



Text fig. 2.

cuticle; whilst in the latter, they commenced as true sclerotia, but as they passed to the exterior of the host became diffuse, and finally resolved into conidiophores. In neither case is any relation to the lenticels mentioned, nor do the figures indicate that this is present.

In addition to these structures in *Aesculus Pavia* true sclerotia are formed in equal abundance. These average from 1·5 mm. to 2 mm. in diameter, and from 0·5 to 1 mm. in thickness (Text Fig. 2, B). They are circular or irregularly oval in outline and possess one convex and one concave side, the latter being closely adpressed to the bark of the host. (Text Fig. 2, B.) The central portion consists of a mass of elongate ramifying hyphae which toward the periphery form a dense and solid tissue enclosed in a brownish-black skin one or two cells in thickness. This skin is absent from the sclerotial ring in contact with the bark (Text Fig. 2, B, p), and this is paralleled by tube cultures of *Botrytis*. Here the sclerotia are strongly concave and most usually adhere to the glass, the narrow, irregular, contact surface of the fungus body being free from the black skin enclosing all other surfaces of the sclerotium. The sclerotia are perfectly discrete bodies with little mycelial attachment at any stage

* Istvánffi, Gy. de: Etudes microbiologiques et mycologiques sur le rot gris de la vigne—Botrytis cinerea ou Sclerotinia Fuckeliana, Annales de l'Institut Central Ampélologique Royal Hongroise, tome iii, 1905.

† Smith, R. E. Botrytis and Sclerotinia: their relation to certain plant diseases and to each other, Bot. Gaz. xxix. 1900.

of their development, and are of a firm cheese-like consistency. Their distribution in the cortex contrasts markedly with that of the pseudo-sclerotia for they are never found correlated with lenticels, but are always adpressed to the unbroken bark (Text Fig. 2, A, B). The sclerotia and conidiophorous-stromata are not successive stages in the development of single bodies; but are discrete entities without intermediate structures, and may be formed simultaneously, for examples of each in various stages of growth are to be found side by side. Whatever the factors may be which determine whether the cortical hyphae at a given spot form a sclerotium, or a stromatic pustule resolving into conidiophores, they evidently bear a direct relation to the lenticels. It is improbable that this stimulus is one of aeration for it is difficult to conceive that this could have so local and so constant an application throughout the diseased cortex. A more probable hypothesis is that the stimulus is one of pressure or contact, and this would derive support from the fact that in tube cultures of *Botrytis*, the conidiophores are formed over the free surface of the medium, whilst the sclerotia are most usually formed in contact with the glass at the periphery.

Distribution of Fungus in the Wood.—The symptoms of extreme drought presented by the specimen had aroused the expectation that the water conducting tissues in the stem would be completely plugged by hyphae. So far from this being the case, however, transverse sections through any portion of the diseased wood showed practically an absence of fungus. The explanation of this was given by radial longitudinal sections for in these it was seen that the mycelium was almost totally confined to the *living* tissues of the central cylinder. From the cortex the fungus passed into the medullary rays which it traversed in a radial direction, and in which it was so abundant as to form the most prominent feature in stained sections, often completely filling the cells of this tissue with masses of fungal hyphae. The mycelium also invaded freely the cells of the wood-parenchyma, but only very rarely could a filament be discovered in any of the water-conducting elements of the stem or in the dead mechanical fibres. The fungus was absent from the pith although ray cells bordering on this tissue contained the fungus in quantity. Sections were taken from all portions of the affected zone, and the constancy and exactitude of this differential distribution confirmed.

Cause of Death of Host.—The absence of the mycelium from the vessels and tracheids immediately proved the original diagnosis to be erroneous, for this was based on the assumption that the water-conducting elements of the stem were choked by masses of hyphae, as in the *Verticillium* disease of potatoes,* or the Wilt disease of cotton.† The extraordinary vigour and turgidity of

* Pethybridge, G. H. The Verticillium Disease of the Potato, Sci. Proc. Roy. Dub. Soc., vol. xv. 1916.

† Smith, E. F. Wilt Disease of Cotton, etc., Div. Veg. Phys. and Path. U.S. Dept. Agr. Bull. 17. 1889.

the new shoots, and the tumescence of the lenticels below the diseased zone, indicated that here there was no lack of water, and that root pressure was operating in a perfectly normal way. On the other hand the rapid wilting and finally the complete desiccation of the tree commencing from immediately above the diseased zone, showed equally conclusively that the passage of this water up the stem was totally inhibited by some factor in the affected region. Yet in this zone itself the water-conducting elements were free from the presence of the fungus, whilst on the other hand the medullary rays and wood-parenchyma tissues were killed and occluded by the hyphae.

These results seemed to lend strong support to the view that the living parenchymatous cells of the wood and medullary rays are fundamentally important and integral parts of the tissues concerned in the raising of water in the plant, a theory early formulated by Westermaier* and Godlewski,† and more recently upheld by Ursprung‡ and in a slightly modified form by Ewart.§

It is well known that if a localised region of a branch still attached to a tree be killed by artificial means, the leaves above this region eventually wilt and shrivel, the rapidity of the fading being roughly proportionate to the length of the affected portion of the branch.¶ According to the above hypothesis the symptoms of drought shown in this case are directly due to the suppression of the vital activity of the cells of the medullary rays and wood parenchyma, which so reduces the supply of water to the foliage above that the leaves quickly fade. Such a condition appears to be exactly paralleled in the present specimen of *Aesculus Pavia*, the artificial lethal agency being replaced by the action of the *Botrytis* mycelium. The general application and truth of this explanation has, however, been subjected to very severe criticism. Strasburger‖ for example in 1891 demonstrated that stems more than ten and a half metres long continued to conduct water after they had been completely killed by steam, and similar experiments have been repeated by many observers since, which seem to prove indubitably that even when the vital activity of the cells of the wood has been eliminated, water under the action of purely physical forces rises in the stems of high trees. It is evident therefore that the inhibition, by death, of the vital functions of the living cells of the central cylinder in a zone ten or twelve centimetres in extent at the base of the specimen of *Aesculus Pavia*, could not be the primary cause of the wilting of the foliage and the desiccation of the tissues.

* Westermaier, W. Zur Kenntniss der osmotischen Leistungen des lebenden Parenchym's Ber. der deut. bot. Gesell., Bd. i, 1883.

† Godlewski, E. Zur Theorie der Wasserbewegung in den Pflanzen, Pringsheim's Jahrb. f. Wiss. Bot. Bd. xv, 1884.

‡ Ursprung, A. Zur Frage nach der Beteiligung lebender Zellen am Saftsteigen, Beihefte z. Bot. Centralb. Bd. 28, 1912.

§ Ewart, A. J. The Ascent of Water in Trees, Phil. Trans. Roy. Soc. Lond. vol. 108B, 1905; and vol. 199B, 1908.

¶ See Janse, J. M. Der Aufsteigende Strom in der Pflanze, Jahrb. f. Wiss. Bot., i, Bd. 45, 1908; ii, Bd. 52, 1913, and Ursprung, A., loc. cit.

‖ Strasburger, E. Ueber den Bau und Verrichtungen der Leitungsbahnen in den Pflanzen, Jena, 1891.

Furthermore it has been abundantly demonstrated by Weber,* Janse,† Vesque,‡ and more recently by Dixon,§ that the cessation of the transpiration stream in a branch which has been killed in a local region, is not due to the removal of the vital activities of the living cells, but to the clogging of the conducting vessels above the diseased region, by the products of the morbid changes in the dead tissues, which contaminate the ascending water-flow. This brown gum-like clogging material is deposited in the walls and lumina of the conducting elements immediately bordering the killed region. The adjoining living cells are stimulated to the development of tyloses and so ultimately the passage of water up the stem is completely blocked. Dixon has also shown that the "physical and chemical nature of the sap is profoundly altered by steaming the branch through which it passes" and that the consequent accumulation of poisonous substances in the leaves ultimately causes their wilting and death, even if these branches are given a double supply of water. Attention may be drawn to the fact that it is not the particular method adopted to kill the localised region, which produces the changes, but the morbid products emanating from the dead tissues. In the case of branches attached to trees the period elapsing before wilting of the leaves becomes evident, is rarely less than four or five days and is usually considerably longer; but shoots experimentally poisoned by the degenerative products may show wilting of the leaves in as short a period as two and a half days,¶ a time corresponding approximately with the wilting period in the present specimen of *Aesculus Pavia.*

It appeared not improbable therefore that in the latter case the death of the tree might have resulted from the combined effect of the poisoning of the leaves, and the clogging of the tracheae, by morbid products arising from the cells of the medullary rays and wood-parenchyma which had been killed by the *Botrytis.* This hypothesis would reasonably correlate the presence of the diseased zone of the tree with the symptoms of rapid and extreme drought shown by the foliage.

There were at once evident, however, a number of facts which would not coincide with this theory. If, for example, the leaves were poisoned by the accumulation in their tissues of necrotic matter, their transpiratory functions would cease before the tracheae in the stem were clogged by morbid products, and the immediate result of this would be a slight excess of water in the tissues of the upper portion of the tree. It is difficult therefore to conceive how such a process could in any way give rise to the state of extreme desiccation exhibited by the wood and cortical tissue of the diseased *Aesculus Pavia.* Furthermore Dixon has

* Weber, C. A. Ueber den Einfluss höherer Temperaturen zu leiten, Ber. d. Deutsch Bot. Gesell. Bd. 3, 1885.

† Janse, loc. cit.

‡ Vesque, J. Sur le prétendu rôle des tissues vivants du bois dans l'ascension de la sève, Compt. rend. Tome 101, 1885.

§ Dixon, H. H. Transpiration and the Ascent of Sap in Plants, London, 1914.

¶ Dixon, H. H.: loc. cit.

pointed out that "the leaves which fade after their supporting branch has been killed by heat, fade in a different manner from those which wilt owing to a lack of water. In the former case the margin of the leaf first becomes darkened and this darkened region gradually invaded the leaf between the veins. It then dries and shrivels whilst the green parts immediately round the veins remain comparatively fresh. As this change is taking place these veins usually become pink and finally brown. This coloration is particularly noticeable when the leaves are viewed with transmitted light. Shrivelling and withering of the leaf, except at the edges, does not occur until after these changes are complete". "On the other hand, when leaves fade simply from an insufficient water supply, *e.g.*, on a branch severed from a tree, shrivelling comes on while they are still green. Blackening appears only after shrivelling and occurs in irregular patches. The veins do not change colour and the walls of the tracheae do not appear coloured in transverse section. The first colour change is when the cell-contents of the mesophyll and parenchyma of the veins colour brown after death". It may again be emphasised that the manner of localised killing, whether by steam, chemicals, fungus mycelium or other lethal agency is without importance; the distinction is one between a process of poisoning by the products of morbid and degenerative changes, and the effects merely of a shortage of water.

Now it has already been noted that in the present specimen of ***Aesculus Pavia*** the leaves at first were limp and flaccid but of a normal green colour. When the tree was taken from the ground three days later the foliage was shrivelled, dry and brittle, and during the subsequent week the leaves merely withered in the manner characteristic of drought, and without any of the symptoms of poisoning.

The desiccated condition of the tissues of the stem, and the manner in which the leaves faded, were strong presumptive evidence that poisoning of the foliage due to contamination of the sap-flow by morbid products, had not occurred. This, however, did not negative the probability that the conducting elements in the stem immediately above the diseased region were choked by the degenerative matter emanating from the dead tissues; and that this clogging, supplemented by tylose formation, was the factor inhibiting the flow of the transpiration stream in the tree.

To determine the soundness of this hypothesis, a careful examination, using microchemical methods, was made of the tissues immediately above the diseased zone and these were compared minutely with corresponding tissues from other parts of the stem. No trace could be detected of any deposition of morbid products either in the walls or in the lumina of the tissues in question, and although, as will be noted later, tyloses were not infrequently present they were not more abundant in this region than in any other portion of the tree. Thus although at first it had appeared probable that the death of the *Aesculus Pavia* under consideration was either a direct result of the suppression of the vital activities of the cells of the medullary rays and wood-parenchyma

in the affected region; or an indirect result of their destruction, by reason of the clogging of the tracheae in the contiguous zone immediately above, by the morbid products of their degeneration; no evidence in support of either of these views could finally be discovered.

It was evident therefore that some other factor existed in the diseased zone; a factor which operated so effectively and rapidly that within a period of a few days a barrier was formed completely checking the upward flow of water in the tree. Below the limit of fungal extension (Pl. vii. Fig. 3, b d b), the tissues were exuberantly healthy and turgescent; above the limit of mycelial growth (Pl. vii. Fig. 3, a c a), the tissues were dry and shrivelled from want of water. In the diseased zone all the living tissues of the stem had been killed and occupied by the fungus, whilst the water conducting channels were free from hyphae. The death of the cortical, ray and wood-parenchyma tissues, was apparently without importance in the conduction of water up the tree; whilst the conducting elements immediately above and below the diseased region were perfectly free from occlusion by morbid products, and did not contain an abnormal number of tyloses.

The only feasible hypothesis remaining seemed to be that although the water conducting tissues of the diseased region of the stem were free from fungus, they must yet be mechanically occluded in some other way. To determine the nature of this occlusion, if present, a thorough visual and microchemical examination of the diseased tissues was carried out, and these were minutely compared with corresponding healthy tissues from below the affected region, and dry tissues from above. The only ascertainable difference was found to be in the relative abundance of tylose formation in the several regions of the stem. In the duramen xylem of all portions of the woody cylinder tyloses were abundant, and in the peripheral actively-conducting tissues of the healthy wood they were not infrequently present. They are thin walled and in almost all cases extend in a single series along the narrow vessels. The tyloses were difficult of accurate observation in the diseased sap wood, for they were collapsed and shrivelled and usually matted closely together. A careful comparative estimation, however, revealed that there were approximately ten times as many tyloses in a given diseased area as in a corresponding area of healthy wood. It was evident therefore that one immediate effect of the fungal invasion had been to stimulate the wood-parenchyma cells to the active formation of tyloses.

Marshall Ward* demonstrated that in the invasion of tissues by *Botrytis* the host cells are killed in advance of the hyphae by an enzymic body secreted by the young fungus cells. Brown† has recently investigated this active principle and has shown that it is possibly a protoplasmic toxin of an enzymic nature and that it possesses a relatively high coefficient of diffusion. Although it has not yet been proved of *Botrytis* extract it is a

* Marshall Ward, H. A Lily Disease, Ann. Bot. vol. ii, 1888.

† Brown, loc. cit.

well known property of many toxic bodies, that in dilute solution they act as growth stimulants, and proliferation of plant cells as a result of exposure to various poisonous substances has recently been abundantly demonstrated by Smith.* When the tissues of the present host were invaded the active principle of the fungus would diffuse rapidly through the cells, and at the extreme limit of its diffusion range it would appear probable that the highly dilute toxic body stimulated the living wood-parenchyma cells to the formation of intrusive vesicles. The period of time during which the tyloses must have been formed could only be very brief, for as has been noted the active principle of *Botrytis* diffuses rapidly, and the toxic substance would very shortly be present in a lethal concentration. Immediately this acted upon the cells of the wood-parenchyma, the tyloses would collapse and shrivel together choking the lumina of the tracheae with dead matter; the rapidity of this process being manifested in the brief wilting period of the foliage of the tree. These plugs of dead tyloses were sufficiently abundant for it to be not improbable that they were primarily responsible for the complete interruption of the water stream in the stem of the *Aesculus Pavia* under consideration.

Longitudinal Extension of Fungus in Host.—As the roots of the tree were in a normal state of activity the blocking of the transpiration current would immediately result in an excess of raw food material in the region below the barrier. Here there had formerly been a few branches the cut ends of which were occluded by wound cork (Pl. vii. Figs. 1, d, and 3, e). The excess of food material stimulated the growth of adventitious buds from this callus, resulting in a whorl of vigorously growing shoots (Pl. vii. Figs. 2 and 1). In addition to utilising the food excess from below, these shoots would, within a certain range draw upon the tissues above them, so that these cells would be depleted of food content, and a "starvation zone" would thus be established between the whorl of shoots, and the downward trend of fungal extension. A careful examination of the tissues shewed that mycelial penetration in a longitudinal direction had apparently ceased, the limits being marked by the discoloured zones already described. Downward this cessation was sudden, corresponding with the sharply defined line which extended across and through the tissues, but which in the sap-wood region always lay above the insertion of the shoots (Pl. vii. Fig. 3, b d b). It was found that in the narrow intervening region, the tissues, although beyond the range of diffusion of the active principle of the fungus, were practically devoid of content, and it would appear probable that the limitation of downward mycelial extension was due to the inability of the *Botrytis* to cross this "starvation zone". In an upward direction the cessation of growth was much more gradual, corresponding with the comparatively broad, diffuse, discoloured zone marking the boundary of the diseased region (Pl. vii. Fig. 3, a c a); and the inability of the fungus to develop further was probably due to the increasing desiccation of the wood.

* Smith, E. F. Mechanism of Tumour Growth in Crowngall, Jour. Agr. Res. vol. viii. 1917.

Infection of the Host.—The conidia of *Botrytis* show very great variability in their power of attacking plants, this depending upon the particular strain of the fungus, upon the host, and upon the incidental conditions in the environment at the time of infection. Marshall Ward found the spores capable of infecting lily leaves, whilst Kissling* describing an epidemic of *Botrytis* among gentians found that the conidia could not attack the leaves. Infection occurred through the stigma and anthers, and this agrees with Nordhausen's results† in which non-cuticularised organs succumbed readily to the attacks of germinating conidia, whilst only under certain special conditions of humidity, lack of light or flaccidity could the leaves be infected. Potter‡ found no difficulty in directly infecting turnips and potato haulms with the conidia of *Botrytis*, whilst Brooks§ could only infect lettuce plants after they had been kept for some days in darkness or were yellowing. Brooks and Bartlett‖ were unable to infect gooseberry bushes with conidia even when these were placed in wounds in the cortex. Tubeuf¶ and Behrens** found that the spores germinated in water and immediately infected young developing shoots and needles of various conifers. Massee†† confirmed this, but stated that the spores cannot pierce the bark of a two year old seedling directly, but only as a wound parasite. I have found no difficulty‡‡ in directly infecting wounded surfaces of fig trees with conidia but have totally failed to infect uninjured surfaces. Blackman and Welsford (loc. cit.) found that spores very often failed to infect a bean leaf, and Brown (loc. cit.) from the same laboratory, has demonstrated that the cuticle of leaves offers a very great obstacle to the action of *Botrytis* extract, and further that with tissues of a "woody texture no definite action could be established in any case". As was pointed out by Marshall Ward (loc. cit.) conidia may in almost all cases be rendered capable of penetrating a cuticularised surface of a leaf or stem if their germ tubes be previously invigorated by saprophytic nourishment. Even this, however, does not appear to give them the power of infecting uninjured bark surfaces, and so far as I am aware all successful inoculations of woody plants by *Botrytis* have been achieved by

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* Kissling, E. Zur Biologie der Botrytis cinerea, Hedwigia vol. 28, 1889.

† Nordhausen, M. Beiträge zur Biologie parasitärer Pilze, Jahrb. Wiss. Bot. 1899.

‡ Potter, M. C. Rottenness of Turnips and Swedes in Store, Journ. Bd. Agric., vol. iii, 1896.

§ Brooks, F. T. Observations on the Biology of Botrytis cinerea, Ann. Bot., vol. xxii, 1908.

‖ Brooks, F. T., and Bartlett, A. W. Two Diseases of Gooseberry Bushes, Ann. Mycol., vol. viii, 1910.

¶ Tubeuf, V. K. F. Beiträge zur Kenntnis der Baumkrankheiten, Berlin, 1888.

** Behrens, J. Phytopathologische Notizen, Zeit. f. Pflanzenkrank Bd. v, 1895.

†† Massee, G. A Conifer Disease, Journ. Bd. Agric., vol. x, 1903.

‡‡ Brierley, W. B. Note on a Botrytis Disease of Fig Trees, Kew Bull. 1916, p. 225.

placing either spores or mycelium on previously wounded surfaces.

In the "die-back" diseases of woody plants caused by *Botrytis* such as those of fig trees* ribes bushes† or roses‡ the germ tubes almost certainly enter through injured buds, while in the "die-back" of conifers, infection obtains through the tender young shoots and leaves. In the diseased sapling lime trees described by Smith and the seedling larches by Massee the attack commenced at the soil level, presumably being a direct invasion by saprophytic *Botrytis* in the soil, which entered through some injury caused probably in transplanting.

In the present specimen of *Aesculus Pavia* the distribution of the *Botrytis* pustules, the youngest being at the upper and lower growing regions and the mature ones being in the centre (Pl. vii. Fig. 1, a) indicates that the primary infection occurred approximately in the middle of the diseased region, and would therefore take place about twenty-six centimetres above the surface of the soil. This eliminates the possibility that the attack was a direct invasion of the tree by saprophytic mycelium from the soil as in the limes and larches noted above, and postulates a spore infection. The brief consideration of the biology of spore infection, however, has shown the great improbability of the penetration of an unwounded bark surface by a germinating conidium; but although a thorough inspection of the diseased area was made no wound could be detected. Nevertheless it is almost certain that a minute wound must have been present, and it would seem probable therefore that infection of the *Aesculus Pavia* occurred by a *Botrytis* spore, which chanced to be inserted under favourable weather conditions in this very minute wound in the bark of the tree—a combination of circumstances rarely to be repeated.

Identity of Fungus.—The conidiophores arising from the stromata in the cortex of the host were of the type characteristic of *Botrytis cinerea*, Pers., although the spores were somewhat larger than usual, measuring 12μ–15μ by $8\mu - 12\mu$. Cultures were made on potato agar of conidia, diseased bark and diseased wood, and in all cases a typical growth of *Botrytis cinerea*, Pers., was obtained. These were compared with cultures of *Botrytis* from the following sources:—(i) a strain growing saprophytically upon dead lilac leaves; (ii) a strain growing saprophytically upon woody mangolia shoots killed by frost; (iii) a strain causing a die-back of young cypress trees; (iv) a strain causing a "die-back" and fruit-rot of fig trees; (v) a strain obtained from the interior of woody galls on a bush of *Ribes alpinum*, Kew. No constant differences could be determined in the several cultures, although on their host plants these fungi vary greatly both in morphology and manner of behaviour. When cultures of *Botrytis* from *Aesculus Pavia* were inoculated into wounded lettuce plants the typical "lettuce drop" developed. Although therefore the

* Brierley, W. B., loc. cit.
† Brooks, F. T., and Bartlett, A. W., loc. cit.
‡ Smith, R. E., loc. cit.

behaviour of the fungus in the present specimen is unusual, there is no evidence to prove that the fungus is a special physiological strain, or other than the common *Botrytis cinera*, Pers. reacting to the stimulus of the particular environment presented by *Aesculus Pavia.*

Other Instances of Woody Trees Killed by Botrytis.—The fungus *Botrytis* is not infrequently found upon large woody trees growing as a saprophyte, and in such cases is usually confined to young shoots and twigs which have been killed by frost, or other agency. Very rarely indeed does it develop in the woody tissues of the main stem. In a few cases the fungus is known as an active parasite upon trees, and then is usually the cause of a "die-back" of the shoots. In the common "die-back" of conifers due to *Botrytis* it cannot be said that the fungus attacks woody tissues for only the soft and tender green shoots are destroyed, and only very exceptionally does the mycelium extend into the older lignified tissues of the branches. In the "die-back" of fig trees, roses, and ribes bushes, it is again usually the young sappy shoots which are attacked. In these cases, however, the mycelium not infrequently develops into the hard lignified regions of the branches and occasionally even invades the main stem of the plants. The hyphae extend in a downward direction, growing most rapidly in the cortex, and gradually spreading inwards eventually penetrating all the tissues of the plant.

Only three cases have been described in which in nature *Botrytis* has invaded a woody host at the base of the plant. The first was by Smith in 1900 (loc. cit.) the host plants being young saplings, three to five feet high, of *Tilia parviflora* and *Tilia grandiflora*. The attack commenced at the ground level, and the hyphae spread rapidly upwards in the tissues discolouring the bark in advance of the wood. The invasion occurred probably during the winter months and its progress was sufficiently slow to permit of the neighbouring saplings becoming fully leaved whilst the diseased trees remained in bud, the buds, however, being green and apparently sound. The cortical tissues were gradually destroyed, but the bast was practically unaffected, and a few fungus filaments only could be found in the outermost portion of the wood. Bursting through the bark were "a sort of half formed sclerotia having the normal cellular structure at the base, but lacking a definite surface layer, and resolving above into a dense mass of conidiophores". Under artificial conditions ordinary black-skinned sclerotia developed later in the cortex. The second instance is given in a brief account by Massee (loc. cit.) of a number of larch seedlings attacked at the soil level by *Botrytis*. The cortex was thoroughly permeated by the fungus which formed sclerotia embedded in the tissues. Later these burst through the bark and gave rise to conidiophores.

In 1903 Miss Lorrain Smith* described a disease of the gooseberry caused by *Botrytis*. The host was attacked at the ground level and the bark destroyed; the mycelium of the fungus per-

* Smith. A. L. A Disease of the Gooseberry. Journ. Bot. vol. xli, 1903.

meating the inner cortex and bast almost to the first branches and downwards into the roots. Sclerotia were found on the outside of the bark.

These cases present a number of interesting comparisons with the diseased *Aesculus Pavia*. In the former the infection occurred at the soil level presumably by *Botrytis* growing saprophytically in the soil and the mycelium spread slowly upwards destroying the cortex. In the diseased *Aesculus* the infection took place probably by a spore some twenty-six centimetres above the soil level and the mycelium spread rapidly in all directions, penetrating the medullary rays as far as the pith. In the gooseberry, lime trees and the larch seedlings there was no direct effect on the transpiration stream and the eventual death of the upper portion of the hosts was merely part of a general necrosis. In the *Aesculus* the cutting of the water supply to the upper part of the tree was rapid and complete, and although not a direct result of mycelial thrombosis, was due to a choking of the conducting elements by tyloses formed as a direct reaction to fungal stimulation. The diseased lime saplings normally showed only a form of conidiophorous stromata, whilst in the gooseberry and larch seedlings true sclerotia only were present; these, however, in the latter apparently very shortly giving rise to conidiophores. In the specimen of *Aesculus* both types of structure were present normally and bore a very definite and constant relation to the lenticels.

Thus the disease of lime trees, gooseberry bushes and larches have much in common, but apart from their similar etiology show little resemblance to the diseased *Aesculus Pavia* under consideration.

Conclusion.

The points of interest in this specimen to which attention may be drawn are as follow:—

The position on the tree at which infection occurred.

The symptoms of the disease and the rapidity with which the host, a comparatively large woody tree, was killed.

The distribution of the fungus in the tissues and especially its absence from the water-conducting channels.

The induction of the formation of tyloses which created an effective barrier to the transpiration stream.

The development by the fungus of conidiophorous stromata and of true sclerotia, and the constant relation of these to the lenticels.

A number of very interesting features were presented by the morphology of the fungus in the tissues, and these will be described in a further communication.

I am glad to record my indebtedness to Miss M. N. Owen, Temporary Technical Assistant in the Laboratory, for the preparation of many slides upon which much of the information in the present paper is based.

Explanation of Text Figures and Plate.

Text Figure 1.—Semidiagrammatic vertical section through a small conidiophorous stroma, *a*—conidiophores; *b* slightly more solid cushion of tissue which resolves into conidiophores; *c*—lose mycelial structure free from host elements; *d*—complex of hyphae, crystals and cortical cells; *e*—mycelium ramifying in the cortical tissue.

Text Figure 2.—Diagrammatic representation of cortex with A—conidiophorous stroma; and B—true sclerotium. A: *a*—conidiophores; *b*—conidiophore cushion; *c*—loose hyphal tissue; *d*—complex of fungus and host elements; *e*—cortical hyphae massing together to form the stroma; *k*—lenticular tissue pushed outwards; *n*—hyphae in cortex; *o*—cambium; *s*—bast fibres; *q*—lacuna in cortex filled by pseudoparenchymatous mass of mycelium. B: *f*—sclerotial skin; *g*—dense tissue of sclerotium; *h*—loose internal tissue; *p*—sclerotial ring from which the dark skin is absent; *m*—unbroken surface of bark.

Explanation of Plate vii.

Fig. 1.—*a*—diseased zone showing *Botrytis* pustules. The young pustules are situated at the margin of the zone, and the mature ones in the middle. Their distribution corresponds with that of the lenticels; *b*—healthy stem shewing tumescent lenticels; *c*—dry stem in which the lenticels may only be seen with difficulty; *d*—wound-callus occluding old branches and giving rise to vigorous adventitious shoots.

Fig. 2.—General appearance of tree immediately after removal from ground. *a*—diseased zone; *b*—whorl of developing shoots; *c*—soil level. The upper portion of the tree is in a thoroughly desiccated condition.

Fig. 3.—Radial longitudinal section through diseased zone; *aca*—upper limit of fungal growth; *bdb*—lower limit of fungal growth; *e*—wound callus from which the new shoots spring; *f*—pustule of *Botrytis*; *g*—fungus pustule showing conidiophorous stroma. Note the dryness of the upper region of the section and the cortex splitting away from the wood. The hollow in the centre of the section represents the position of the pith.

XXXV.—THE GENUS COCOS.

In 1886 Dr. O. Beccari published in Malpighia vol. i. p. 343, a preliminary study of the palms included in the genus *Cocos*, Linn.; he has now supplemented this by a revision, published in the L'Agriculture Coloniale, x. p. 435 (Florence, 1916), in which nine distinct genera are recognised and distinguished as in the key reproduced below. *Barbosa*, *Arecastrum*, *Butia* and *Glaziova*, regarded as subgenera in the earlier publication, are now raised to generic rank, but the name *Glaziova*, Mart. (1871), has been replaced by that of *Syagrus*, Mart. (1824), in order to

avoid confusion with a genus of the same name belonging to *Bignoniaceae* and described by Bureau in 1868; *Butia*, however, is retained, although *Butea*, Koenig (*Leguminosae*, 1795), is a valid genus. These subgenera being eliminated, *Cocos* becomes a monotypic genus, with *C. nucifera*, Linn., as its only species.

The following key gives the diagnoses of the genera of this group.

Key to Cocos and allied genera.

I. Flores foeminei ovati vel ovato-conici, sepalis acutis vel cucullatis, petalis apice valvatis.

*Spatha superior extus plus minusve profunde plicato-sulcata.

1. Albumen ruminatum.

Nucleus 1-locularis, pariete tenuiter lignosa, apice operculo rostrato clausus. Albumen oleosum in medio late cavum. Frondium petiolus ad margines inermis	**Barbosa**, *Becc.*
Nucleus 1-locularis, pariete crassissima ossea. Albumen siccum in medio anguste cavum. Frondium petiolus ad margines inermis	**Rhyticocos**, *Becc.*
Nucleus vulgo 1-locularis (vel interdum 2-locularis), pariete tenui, fragili. Albumen vix in centro cavum. Frondium petiolus ad margines spinosus.	**Arikury**, *Barb.-Rodr.*

2. Albumen aequabile. Frondium petiolus ad margines laevis vel fibrosus.

Nucleus 1-spermus, pariete crassa ossea intus plicato-gibbosa, foraminibus profunde impressis subbasilaribus; loculorum sterilium vestigiis angustis in substantia ossea endocarpii inclusis. Semen irregulare, gibboso-uncinatum; embryone basilari. Ovarium dense papilloso-pilosum. Truncus annulatus ...	**Arecastrum**, *Becc.*
Nucleus 1-spermus, endocarpii cavitate regulari, conspicue 3-vittata, loculorum sterilium vestigiis membranacesis Semen regulare, embryone basilari	**Syagrus**, *Mart.*

**Spatha superior extus aequalis (non plicato-sulcata).

†Floris masculi stamina 6. Frondium petiolus ad margines conspicue spinosus.

Nucleus 3-spermus, vel abortu 1-2-spermus, loculis regularibus, dissepimentis osseis, foraminibus superificialibus (non impressis); mesocarpium pulposo-fibrosum. Semen regulare; albumine intus vix vel anguste cavo; embryone laterali. Ovarium glabrum. Truncus cicatricibus numerosis depressis signatus ... **Butia,** *Becc.*

††Floris masculi stamina 9 vel plurima. Frondium petiolus ad margines inermis.

Floris masculi stamina numerosa; calyx 3-partitus, basi in pedicellum attenuatus. Fructus globoso-ovatus, nucleo 1-spermo; mesocarpio carnoso-fibroso; endocarpio intus 1-vittato, paullo infra medium 3-poroso; loculorum sterilium vestigiis angustis, in substantia ossea endocarpii inclusis; albumine intus cavo; embryone laterali ... **Jubaea,** *H.B. & K.*

Floris masculi stamina 9-16; calycis sepala libera, basi imbricata. Fructus globosus, nucleo 1-spermo; mesocarpio exucco fibroso; endocarpio intus 1-vittato, supra medium 3-poroso; loculorum sterilium vestigiis obsoletis; albumine intus cavo; embryone laterali **Jubaeopsis,** *Becc.*

II. Flores foeminei globosi, magni; sepala et petala concavo-cucullata et arcte convoluto-imbricata. Spatha striata (non plicato-sulcata).

Floris masculi sepala libera, basi imbricata; stamina 6, Fructus magnus 1-locularis, 1-spermus; mesocarpio spisse fibroso-suberoso endocarpio tenuiter osseo, basi 3-poroso, intus linea umbilicali opaca percurso; loculorum sterilium dissepimentis coriaceis contra endocarpii parietem internam propulsis; albumine oleoso amplissime effosso; embryone basilari ... ... **Cocos,** *Linn.*

The following list has been compiled from Dr. Beccari's paper to show the changes in nomenclature proposed for species which have been in cultivation. The second list gives the names of plants which have been cultivated under the name of *Cocos*, but which have not been definitely identified owing to the absence of flowers or fruit or sufficient information.

PLANTS CULTIVATED UNDER THE NAME OF COCOS WITH THE NAMES NOW ACCEPTED.

The figures refer to the pages in Beccari's paper.

C. Arechavaletana, Barb. Rodr. **Arecastrum Romanzoffianum,** var. **australe,** *Becc.*, 459.

C. australis, Hort. = **Butia capitata,** *Becc.*, 507 (usually).

C. australis, Mart. = **Arecastrum Romanzoffianum,** var. **australe,** *Becc.*, 459.

C. Bonetti, Hort.
C. Bonneti, Linden = **Butia Bonneti,** *Becc.*, 504.
C. Bonnetti, Hort.

C. campestris, Mart. = **Syagrus campestris,** *H. Wendl.*; *Becc.*, 465.

C. capitata, Mart. = **Butia capitata,** *Becc.*, 507.

C. Chirita, Hort. = **Diplothemium maritimum,** *Mart.* (ex H. Wendl); *Becc.*, 612.

C. comosa, Mart. = **Syagrus comosa,** *Mart.*; *Becc.*, 466.

C. coronata, Chabaud, non Mart. = **Butia capitata,** var. **subglobosa,** *Becc.*, 513.

C. coronata, Mart. = **Syagrus coronata,** *Becc.*, 466.

C. coronata, var. *Todari*, Becc. = **Syagrus coronata,** var. **Todari,** *Becc.*, 466.

C. Datil, Gris. et Dr. = **Arecastrum Romanzoffianum,** var. **australe,** *Becc.*, 459.

C. elegantissima, Chabaud = **Butia capitata,** var. **elegantissima,** *Becc.*, 517.

C. elegantissima, Linden = **Syagrus Weddelliana,** *Becc.*, 468, 612.

C. eriospatha, Mart = **Butia eriospatha,** *Becc.*, 496.

C. erythrospatha, Chabaud = **Butia capitata,** var. **erythrospatha,** *Becc.*, 515.

C. flexuosa, Mart. = **Syagrus flexuosa,** *Becc.*, 466.

C. flexuosa, Hort., non Mart. = **Arecastrum Romanzoffianum,** var. **australe,** *Becc.*, 613.

C. insignis, H. Wendl. = **Syagrus insignis,** *Becc.*, 467.

C. Jatta, Hort. = **Copernicia robusta,** *H. Wendl.* (ex H. Wendl.); *Becc.*, 614.

C. lapidea, Hort., non Gaertn. = **Arecastrum Romanzoffianum,** var. **botryophorum,** *Becc.*, 614.

C. lejospatha, Barb. Rodr. = **Butia lejospatha,** *Becc.*, 520.

C. lilaceiflora, Chabaud = **Butia capitata,** var. **lilaceiflora,** *Becc.*, 518.

C. longifolia, Hort. = **Attalea excelsa,** *Mart.* (ex H. Wendl.); *Becc.* 614.

C. mammillaris, Hort. = **Butia Yatay,** *Becc.*, 498.

C. minima, var. *glauca*, Hort. = **Syagrus Weddelliana,** var. **Pynaertii,** *Hort.*; *Becc.*, 615.

C. Normanbyi, W. Hill, = **Normanbya Muelleri,** *Becc.*, 615.

C. nucifera, *Linn.*; *Becc.*, 532.

C. odorata, Barb. Rodr. = **Butia capitata,** var. **odorata,** *Becc.*, 513.

C. pernambucana, Lodd. = **Syagrus botryophora,** *Mart.* ?; *Becc.*, 616.

C. plumosa, Hook. = **Arecastrum Romanzoffianum,** var. **genuinum,** *Becc.*, 447.

C. Procopiana, Glaz. = **Syagrus macrocarpa,** *Barb. Rodr.*; *Becc.*, 467.

C. Romanzoffianum, Cham. = **Arecastrum Romanzoffianum,** var. **genuinum,** *Becc.*, 447.

C. Rossii, Hort. = **Attalea Cohune,** *Mart.* (ex H. Wendl.); *Becc.*, 616.

C. schizophylla, Barb. Rodr., non Mart. = **Butia Bonneti,** *Becc.*, 504.

C. Urucuru, Hort. = **Attalea excelsa,** *Mart.*; *Becc.*, 617.

C. Weddelliana, H. Wendl. = **Syagrus Weddelliana,** *Becc.*, 468.

C. Yatay, Mart. = **Butia Yatay,** *Becc.*, 498.

Imperfectly known species.

C. attaleoides, Hort.
C. Balansae, Naud.
C. Blumenavia, Hort.
C. botryophora, Hort.
C. Butaei, Hort.
C. coronata, Hort., non Mart.
C. fernambucensis, Hort.
C. frigida, Linden
C. Gaertneri, Blumenau
C. gummosa, Hort.
C. Kotchoubeyi, Linden
C. latifolia, Hort.
C. majestica, Hort.
C. maritima, Hort.
C. Maximiliana, Hort.
C. ovata, Lodd.
C. Piassaba, Hort.
C. reflexa, Hort. Berol. (*Syagrus reflexa*, H. Wendl.)
C. regia, Linden, non Liebm.
C. sylvestris, Hort.
C. Tamaca, Linden
C. Wallisii, Linden
C. Yurumaguas, Linden

XXXVI.—THE INTRODUCTION OF THE SPRUCE FIR INTO BRITAIN.

L. A. Boodle.

A fragment of wood was sent to Kew not long ago by Major V. A. Farquharson, as the identification of the wood was desired in connection with a matter of historic interest, the specimen being a portion of a pole thought to belong to the banner of Scotland captured in the battle of Pinkie in 1547.

An examination of the specimen led to the conclusion that the wood is either Spruce or Larch.

These two trees are not native in Great Britain*, but have been grown in the country for a long time. Botanical works were therefore consulted for statements as to the dates of introduction of Larch and Spruce. The information elicited gives no evidence that either of these had been introduced as early as 1547. A note on the subject has been drawn up, for the reason that a misapprehension appears to have arisen in the case of the records relating to the Spruce.

A reference to the Larch being grown in Britain is made by Parkinson (Paradisus Terrestris, 1629, p. 608), and this is apparently the earliest record, as stated by Loudon (Arboretum et fruticetum britannicum, 1838, vol. 4, p. 2358). Parkinson writes as follows:—"The Larch tree where it naturally groweth, riseth up to be as tall as the Pine or Firre tree, but in our land being rare, and noursed up but with a few, and those only lovers of rarities, it groweth both slowly and becometh not high."

Thirty-five years after the date of Parkinson's "Paradisus" the larch still appears to have been rare, but there was at least one good-sized specimen in the country. This is referred to by Evelyn in his "Sylva" (1664, p. 57) as follows:—"That which now grows somewhere about Chelmsford in Essex, arriv'd to a flourishing and ample Tree, does sufficiently reproach our negligence and want of industry." That large trees were still uncommon a hundred and twenty years later is suggested by the fact that in the 1786 edition of the "Sylva" (vol. 1, p. 310) reference to the same reproach is made in slightly different words, and that the reminiscence of a single specimen, presumably the same one, and here described as "a tree of goodly stature, not long since to be seen about Chelmsford," is chosen as an object lesson. Young trees were however abundant, the larch being stated (vol. 1, p. 280) to be "now very common in all the nurseries of the kingdom."

One may conclude with Elwes and Henry (The Trees of Great Britain and Ireland, ii., 1907, p. 353) that the Larch was probably introduced at about the beginning of the seventeenth century.

An earlier date of introduction is claimed for the Spruce by

* The Spruce (*Picea excelsa*, Link) was formerly indigenous, remains of this species having been found in the Preglacial Cromer Forest-bed at different localities in Norfolk, though unknown in Britain in later deposits. See Clement Reid, The Origin of the British Flora (1899), p. 151.

Loudon (loc. cit., vol. 4, p. 2302). It will be as well to give his statement in full. "Though the Spruce fir is generally allowed not to be a native of Britain, it appears to have been introduced at a very early period, as Turner includes it in his Names of Herbes, published in 1548, and both Gerard and Parkinson not only give very good engravings of it, but speak of its being found in great quantities in different parts of the island. The early British writers on trees, however, appear to have confounded the Scotch pine with the Spruce fir, and it is remarkable that neither of the above-mentioned writers mentions the Scotch pine at all, though it is probably the tree Parkinson means, when he speaks of the 'firre tree' growing wild in Scotland."

The same evidence is relied on by later writers. Elwes and Henry (loc. cit., vi., 1912, p. 1351), for example, write thus of *Picea excelsa*:—"It appears to have been introduced early in the sixteenth century, as Turner includes it in his Names of Herbes published in 1548; and both Gerard and Parkinson state that it was found in different parts of Britain."

Turner's reference to the Spruce (The Names of Herbes, 1548) is in these words:—"Picea is called in greeke as Theodore Gaza turneth, pitys and after Ruellius peuce* and it is called in duch rottē Dan, wherfore it may be called in englishe a red firre tree." It is difficult to understand why this mention of the Spruce should have been brought forward as evidence that the tree was grown in Britain at the date of Turner's publication, especially as the Larch is also included in his list.

The fact, noted by Loudon, that both Gerard and Parkinson give engravings of the Spruce, proves nothing, since these figures are taken from the works of earlier authors. Thus Gerard's illustration on p. 1172 of the Herball (1597) is the same as that given by Tabernaemontanus (Eicones Plantarum, 1590, p. 940), while the figure in the 1636 edition of Gerard's Herball (p. 1354) and in Parkinson's Theatrum Botanicum (1640, p. 1538) is to be found in Lobel's Plantarum seu Stirpium Historia (1576, p. 633).

On referring to Gerard and Parkinson for the statement attributed to these authors by Loudon, that the Spruce was "found in great quantities in different parts of the island," no such information could be found. Gerard's reference to distribution (The Herball, 1597, p. 1172; also 1636 edition, p. 1354) reads: "The Pitch tree groweth in Greece, Italy, France, Germanie, and all the cold regions even unto Russia," while Parkinson (Theatrum Botanicum, 1640, p. 1539) merely says:—"The first [i.e. *Picea vulgaris*, The ordinary Pitch tree] groweth usually in all countries with the Firre trees, but seldom neere the Sea."

It appears therefore that a record of the Spruce being grown

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* The index of plants at the end of Hort's "Theophrastus' Enquiry into Plants" (1916), does not include the Spruce. Four species of *Pinus* are given as the equivalents of different trees referred to by Theophrastus under πεύκη and πίτυς, no mention of Spruce having been identified under either of these names.

in this country as early even as 1640 has still to be found.* Moreover the absence or rarity of the tree at a later date may be inferred from Evelyn's remark in Sylva (1664, p. 53):—"I am not satisfied why it [*Picea*] might not prosper in some tolerable degree in England, as well as in Germany, Russia the colder tracts and abundantly in France." The same sentence is repeated in the 1670 edition, while in that of 1786 (vol. 1, p. 278) one reads that the Common Spruce Fir Tree "is a native of Norway and Denmark, where it grows spontaneously, and is one of the principal productions of their woods. It also grows plentifully in the Highlands of Scotland, where it adorns those cloud-capped mountains with a constant verdure." This reference to Scotland appears to be an example of the confusion between Spruce and Scotch Pine mentioned by Loudon, and is surprising at so late a date. Parkinson's reference to the fir tree growing wild in Scotland should presumably also be interpreted as applying to the Scotch Pine, as suggested by Loudon. The sentence in question (Theatrum Botanicum, 1640, p. 1539), which comes under the heading of "Abies, the Firre tree," reads:—"This tree groweth in all the Countries of Germany, Polonia, Denmarke and Macedonia, and in divers other Countries also in Italy, Greece, etc., in Scotland also, as I have beene assured, but not in Ireland or England, that I can heare of, saving where they are planted, and whether there was ever any growing naturally in England at any time heretofore is almost out of question."

To summarise the result arrived at with regard to the Spruce:—no confirmation of the current opinion, that this tree had been introduced by the middle of the sixteenth century, has been obtained; and, further, the references to it quoted above suggest that the Spruce may even have been introduced at a later date than the Larch.

To return to the question of the specimen of wood referred to at the beginning of this note, one may conclude that there was no home-grown timber of either larch or Spruce in the year 1547, and that the pole, assuming its supposed history to be correct, must have been made from imported timber.

Early in the seventeenth century, wood, including masts for ships, was among the imports into Scotland from the continent, as shown by a list of Customs and Valuations of Merchandises of the year 1612.† Similar imports of timber were probably being made in the middle of the sixteenth century, and might have come from Antwerp, whither timber for ship-building was at that time brought by sea from Norway, Sweden, Poland and

* "Picea" is included in Gerard's catalogue of plants cultivated in his garden (Catalogus arborum, etc.), published in 1596, but is omitted from the 1599 edition. As this omission may imply the discovery of an incorrect determination, the record is at any rate under suspicion. "Abies, The Firre tree" is given in 1599, and is taken by Jackson (A catalogue of Plants cultivated in the Garden of John Gerard in the years 1596-1599, ed. B. D. Jackson, 1876), to mean *Pinus Abies*, L. (i.e. *Picea excelsa*), but the correctness of this interpretation may be doubted, especially as "Abies" and "Picea" both occur in the 1596 list.

† See Ledger of Andrew Halyburton, 1492–1503, Edinburgh, 1867.

other countries.* As a good deal of this timber, especially that intended for masts, is likely to have been Spruce, there is nothing improbable in supposing that this wood was available, and that the choice of it for the making of a pole might even be expected.

XXXVII.—MISCELLANEOUS NOTES.

The Fruits of Cydonia japonica and C. Maulei.—The crop of these fruits, usually good, is this year exceptionally so, and owing no doubt to the prevailing desire to utilize everything possible for food, a good many samples have been sent to Kew with a request for information as to their edibility, etc. Like all quinces, they are too harsh and acid to be eaten raw. Nor can they be used by themselves for cooking in tarts, but a few slices may be put in apple tarts for flavouring. The only form in which they can be considered palatable is in that of a jelly. Last year, fruits of *Cydonia Maulei* and of five varieties of *C. japonica* were sent from the Kew collection to the Rev. J. Jacob, of Whitewell Rectory, Whitchurch, Salop, for him to experiment with for jelly-making. He reports that they were all treated alike and that after trying each one "without knowing which was which, he and two friends agreed that the *Maulei* jelly was the best. Then came *C. japonica coccinea*; then *C. j. floribunda*; then *C. j. umbilicata*. The other varieties of *Cydonia japonica* were hardly different from wild crab apple jelly." It is interesting to find differences in the quality of these garden varieties which were, of course, raised originally with a view to flower beauty only.

Whilst the present dearth of sugar continues there will be small opportunity of utilizing the fruits of these Japanese quinces. But when happier times arrive it is evident from Mr. Jacob's report that a conserve, excellent and new to many, may be made from fruits that have mostly been allowed to rot on the ground.

W. J. B.

Chatubinskia, *Rehmann.*—During his travels in South Africa in 1875 to 1877 Dr. Rehmann collected a large number of mosses and Hepaticae, which he distributed in sets accompanied by printed labels bearing details as to the habitat and in most cases also the determination. Amongst the mosses were many proposed new species of which descriptions were not published at the time, but this was done in some cases by Dr. Carl Mueller in Hedwigia, xxxviii. pp. 52-155 (1899), while others were merely enumerated in the Revue Bryologique, 1878, pp. 69-71, and in General Paris' Index Muscorum, but up to the present time no general list of this valuable collection has appeared. No. 595, collected in the Transvaal, was regarded by Rehmann as a new genus, for which he proposed the name *Chatubinskia africana*, which up to the time of the recent issue of T. R. Sim's Handbook of the Bryophyta of South Africa

* See Ledger of Andrew Halyburton, 1492-1503, Edinburgh, 1867, Preface, p. xxxvii.

(p. 199) had been neither described nor identified. The specimen at Kew shows that this is not a moss, but the almost cosmopolitan hepatic, **Herberta juniperina,** *Spruce*, in Trans. Bot. Soc. Edinb., xv., p. 342 (1885); *Jungermannia juniperina*, Sw. Fl. Ind. Occ., p. 1855 (1806); *Schisma juniperinum*, Dmrt. Comm. Bot., p. 114 (1822); *Sendtnera juniperina*, Nees in Gott., Lindenb. et Nees, Syn. Hepat., p. 239 (1844).

The locality given on Rehmann's label is: "Transvaalia; in silvis primaevis mont. Lechlaba in latere meridionali in summi montis Snellskop ad arborum truncos." C. H. W.

Candle Nut or Indian Walnut (*Aleurites triloba*, Forst.).—A tree 40 to 60 ft. high; native of Polynesia and Malaya, distributed by cultivation to India, Burma, Ceylon, Hongkong, Mauritius, West Indies, East Africa (specimens of nuts sent to Kew from Blantyre) etc.

Allied species *A. cordata*, R. Br., *A. Fordii*, Hemsl., and *A. trisperma*, Blanco, have been dealt with in previous issues of the Bulletin (see "Chinese Wood Oil," 1906, pp. 117-119, pp. 398-399; "The Wood-oil Trees of China and Japan," 1914, pp. 1-4; and "A Revision of the Synonymy of the Species of Aleurites," 1906, pp. 119-120). As a source of oil the species under consideration is of equal importance, though it has not previously been given a place in the Bulletin, except for synonymy (1906, p. 121) and a short note under Fiji Islands (1887, Sept., p. 7), where it is stated "this plant is widely distributed in tropical countries. The seeds contain a large quantity of oil, which is obtained by expression, and because of its drying properties is used for mixing with paints under the name of Country Walnut Oil. The kernels, when dried and stuck upon a stick, are used as candles in the Polynesian Islands."

The nuts and oil have been reported to be edible; but this is open to serious question, as considerable difference of opinion exists amongst writers on the point. Having regard to the Order (*Euphorbiaceae*), and the close alliance with species known to be distinctly poisonous, it would be advisable not to rely on the oil for table use; it can be readily dispensed with for this purpose since we have so many more oils of proved quality and that come nearer the standard of "olive oil." The nuts might pass locally for food, but only when quite fresh. According to the Tropical Agriculturist (*seq.* p. 300) "the half-ripe fruits with salt have a delicate flavour, but the ripe fruits are unwholesome and only eaten in time of scarcity." This uncertain character is borne out by the variation in analyses of the oil—some comparisons of which are given in Colonial Report, No. 88 (Misc. Series), 1914, pp. 449-450—extracted from nuts forwarded from Hongkong and Mauritius to the Imperial Institute. The oil, however, is of growing importance because of the industrial uses to which it may be put, and the above report bears out the opinion already referred to as to the drying properties, typified by linseed oil, and recommends it "for the manufacture of soft

soap, the preparation of oil varnishes, paints, and linoleum and for other similar purposes to which oils of this class are applied industrially." Further, the value (1906) for nuts in Europe is given at £12 to £13 per ton, and of the oil (1911) at £28 to £30 per ton, with the residual cake at £1 10s. to £2 per ton—suggested for fertilising. The percentage of oil in the kernels has been variously quoted at from 50 to 68 per cent., and where the oil cannot be expressed locally it is recommended that only the kernels be exported to this country. An analysis of the kernels from one of the Pacific Islands is recorded in the "Agricultural Gazette" of New South Wales for August, 1906, and also in "Agricultural News," Barbados, Oct. 6, 1906—showing "Moisture, 8·23; Albuminoids, 8·04; Oil, 59·93; Fibre, 2·62; Ash, 3·56; Carbohydrates (by difference) including pectous bodies."

The nuts have been submitted to Kew for identification under the names "Mireken Nut" and "Kemiri Nut," as well as the more general one of "Candle Nut." In Ceylon they are known as "Kekuna," and an important paper entitled "Candle Nut (Kekuna) Oil as an Industry" is published in the "Tropical Agriculturist," vol. xlviii., May, 1917, pp. 300-302, urging its cultivation which, as the tree grows so freely, should not be attended with any difficulty. Planting 25 to 30 ft. apart in protected situations up to 2600 ft. above sea-level is recommended, and the tree is said to bear at the end of the second year.

J. H. H.

Strychnos Nux-vomica in Cochin-China.—In *K.B.* 1917, pp. 184, 185, some evidence is given as to the occurence of this species in Cochin-China in the wild state. Since the account was written a letter and a packet of undoubted *Nux-vomica* seeds have been received from the Director, Agricultural and Commercial Services, Cochin-China, with the information that the seeds were obtained from trees growing wild in the country.

H.B.M.'s Consul, Saigon, also sends the following information about *S. Nux-vomica* in Cochin-China which he has received from Monsieur Morange, Director of the Agricultural and Commercial Services of Cochin-China, and also a sample of the seeds obtained from a Chinese exporter.

The tree exists in the Eastern provinces of Cochin-China, principally in the forests of Baria. The seeds are bought by Chinese from the savage tribes known as Mois, who collect them in the forest; the Chinese then export them to China or sell them again to firms exporting to Europe. The time of fruiting is in November and December. M. Morange considers that the tree is certainly indigenous in Cochin-China, and was not introduced by early traders.

Strychnos psilosperma.—We have received from Mr. J. H. Maiden, F.R.S., Botanic Gardens, Sydney, an excellent set of specimens of this Australian *Strychnos*, showing both the adult and juvenile states, collected by Dr. T. L. Bancroft, in the

Eidsvold District, Queensland. This species forms a shrub from 6-15 ft. high, and on an average about 10 ft. high. In the axils of some of the leaves of the young shoots slender terete spines, about 1 cm. long, are present, which are caducous and are not usually seen in herbarium material. No other specimens at Kew or in other British herbaria show the spines, but they were met with by Mueller, who mentions in his original description that the species is occasionally spinescent. This character is not referred to in *K.B.* 1917, p. 171, but the similar, though longer, spines of the *S. arborea,* which Mr. Maiden informs us is a stout sturdy tree, are figured on p. 172. The figure has been inverted by mistake. A. W. H.

Enneapogon mollis in Ascension Island. In *K.B.* 1917, p. 217, an account is given of the sudden appearance of this grass in the island. A further letter has now reached us from the Director of Victualling, Admiralty, enclosing the following extract from a later letter received from the Farm Superintendent, giving further particulars about the grass:-

"The grass appeared first in Wide-a-wake Plain—it was probably brought entangled in the feathers of the Sooty Tern, which nest on this Plain in millions about every eight months, and after rearing their young all depart again, either to the West Coast of Africa or elsewhere.

"Being in the strong trades here, the seed only blew from the Plain in a north-westerly direction, covering in a large, fan-like shape to Garrison the intervening land for $3\frac{1}{2}$ miles by 2 miles at the front—behind the Plain, to windward, no grass was growing.

"I have since collected some seed and have sown it to windward in other places and am now awaiting results. The grass first made its appearance in the hot season in February and March, after the heavy tropical rains, which were unusually plentiful this year. It commenced to seed in April and May, and lasted on as green grass till August—the heavy rains end about July, when the grass, which is an annual, commenced to dry off and the ground is at present covered with the dry grass and a great quantity of seed.

"I am now anxious to see what happens after the next heavy rains, which may occur again next year; but I have known five consecutive years with scarcely any heavy rain on the lower levels of the island, up to 1000 ft.

"Every endeavour should be made to make as much hay as possible if the grass appears again, for the little we made is excellent, and its nature reminds me of hay made in England from Trifolium."

Bark-peeling of Plane Trees.—A phenomenon which has been very noticeable this year, both in this country and in France, is the excessive peeling of the bark from the trunk and main branches of the common plane—*Platanus acerifolia.* During the high winds of October the ground in the neighbourhood of plane

trees was strewn with flakes, not only numerous, but unusually large. In France, where the peeling commenced in July, flakes of bark have been observed to be occasionally as much as 6 ft. in length. It is many years since our plane trunks have shown so clean and well-groomed an appearance. The plane, of course, sheds its bark regularly, and what has happened this autumn is that, in addition to the normal release of bark, a future shedding probably has been anticipated. The Boulevards in Paris in particular have presented a remarkable sight with the perfectly clean lemon-yellow, or pale orange trunks and branches of the freshly-stripped trees. In attempting to account for this decortication there are two circumstances that suggest themselves as having possibly some connection with it. These are the severity of the winter and early spring of 1916-1917, and the especially good growing weather of the past summer. The winter frosts may have loosened the hold of the outer bark. Certainly the favourable summer of 1917 must have induced an unusual expansion of the trunk, and this would, of course, also help towards the detachment of the outside and effete layer of bark. It can be noticed that the trunks, as a general rule, but with exceptions, are at present more denuded of bark on the south side than on the north. This may be due to the influence of the sun, or to that side being more exposed to strong winds, or to both.

Plant Materials of Decorative Gardening.* —We have received a copy of a little work bearing this title from the author, Prof. Trelease, of the University of Illinois. It is an attempt to make it possible for any careful observer to learn the generic and usually the specific name of any hardy tree, shrub, or woody climber that he is likely to find cultivated in the Eastern United States—apart from the extreme south—or in Northern Europe, anywhere except on the more pretentious estates, or in nurseries or botanical establishments. The volume is a thin one, measures only 6 in. by 4½ in., and is composed of 204 pages. It is, therefore, of very convenient pocket size. Making allowance for its dimensions, we consider the book very creditably achieves its aim. The keys are arranged on the dichotomous system, and as regards the genera, we find they work very well. And for the gardens of Eastern North America, the keys of species, no doubt, are equally useful. But for this country, where the number of cultivated trees and shrubs is much greater, we find the lists of species, especially of the more important genera, often too meagre to fulfil their purpose. Of *Cotoneaster*, for instance, six species only are "keyed," of which but one, *C. microphylla*, is commonly grown in our gardens. Such common species as *C. frigida*, *C. horizontalis*, *C. bacillaris and C. Simonsii* are not mentioned. Of *Elaeagnus*, again, the evergreen and most popular species, are not included. In spite of this, however, the book is

* Plant materials of Decorative Gardening—The Woody Plants. By William Trelease, Professor of Botany in the University of Illinois. Published by the Author. Urbana, 1917.

a very valuable one, and contains a remarkable amount of information compressed in small space. The key to the genera of woody plants is especially useful, and it is supplemented in the body of the work by a concise and accurate description of each genus. W. J. B.

Botanical Magazine.—The following plants are figured in the numbers for July, August and September:—*Pinus tuberculata*, Gord. (t. 8717) from Western North America; *Odontoglossum platycheilum*, Weathers (t. 8718) from Guatemala; *Oreocharis Forrestii*, Skan (t. 8719) a native of North-Western Yunnan; *Sinofranchetia chinensis*, Hemsl. (t. 8720) from Western Hupeh and Szechuan; *Rhododendron Cuffeanum*, Craib (t. 8721) from Upper Burma; *Berberis aggregata*, Schneider (t. 8722) a native of Western China; *Bulbophyllum lilacinum*, Ridl. (t. 8723) from the Malay Peninsula and Siam; *Polygonum Griffithii*, Hook. f. (t. 8724) from Northern India and Western China; *Odonotoglossum chiriquense*, Reichb. f. (t. 8725) from Costa Rica and Colombia; *Oresitrophe rupifraga*. Bunge (t. 8726) from North China; *Rhododendron neriiflorum*, Franch. (t. 8727) from Yunnan, and *Aster fuscesens*, Bur. et Franch. (t. 8728) from Western China.

In the numbers for October, November and December the following plants are figured:—*Pleione Pricei*, Rolfe (t. 8729) a native of Formosa; *Castilleja miniata*, Dougl. (t. 8730) from Western North America; *Orthrosanthus Chimboracensis*, Baker (t. 8731) extending from Mexico to Peru; *Daphne Giraldii*, Nitsche (t. 8732) from China; *Prunus subhirtella* var. *autumnalis*, Makino (t. 8733) from Japan; *Megacarpaca polyandra*, Benth. (t. 8734) from the Himalaya; *Primula nutans*, Delavay (t. 8735) from Yunnan; *Rhododendron Fargesii*, Franch. (t. 8736) from China; *Sarcochilus solomonensis*, Rolfe (t. 8737) a native of the Solomon Islands; *Sechium edule*, Sw. (t. 8738) from Tropical America; *Syringa Wilsonii*, Schneider (t. 8739) from Western Szechuan; *Cryptophoranthus Dayanus*, Rolfe (t. 8740) from Colombia and *Grevillea oleioides*, Sieb. (t. 8741)), a native of New South Wales.

The volume for the year is dedicated to Mr. R. I. Lynch, Curator, Botanic Garden, Cambridge.

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